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DEPARTMENT OF COMMERCE TECHNOLOGY PROGRAMS AUTHORIZATION

HEARING

BEFORE THE

SUBCOMMITTEE ON
SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE,
SCIENCE, AND TRANSPORTATION
UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

FIRST SESSION

ON

REAUTHORIZATION OF THE TECHNOLOGY PROGRAMS OF THE DEPARTMENT OF COMMERCE

MARCH 17, 1987

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REAUTHORIZATION OF THE TECHNOLOGY PROGRAMS OF THE DEPARTMENT OF COMMERCE

TUESDAY, MARCH 17, 1987

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:05 a.m., in room SR-253, Russell Senate Office Building, Hon. Donald W. Riegle, Jr., Chairman of the subcommittee, presiding.

Staff members assigned to this hearing: Pat Windham, professional staff member and Mark Farrell, minority professional staff member.

Senator RIEGLE. The subcommittee will come to order.

Dr. Ambler, let me ask you to come to the table, and also Dr. Merrifield, if he is here.

I understand Dr. Merrifield apparently has been delayed, so we will take him when he arrives.

Senator Hollings, I know that you have a very strong interest in this. So, before I make my opening statement, I am going to call on you to make whatever comments you might wish to make at this point.

OPENING STATEMENT BY THE CHAIRMAN

The CHAIRMAN. I thank you very much, Mr. Chairman.

As you know, with regard to the National Science Foundation, NASA, and others in the scientific world, we find that one of the great problems that exists today is the commercialization of new technology. Seemingly we in America are discovering it, but we are not producing it. We are not commercializing it.

The one institution that has been helping commercialization in a very modest way, but in a very quiet and meaningful way, has been our National Bureau of Standards. I am familiar with what we call the RAMP Project with the U.S. Navy in Charleston, S.C., the Rapid Acquisition of Manufactured Parts Program. The technology used there actually is that of the Bureau of Standards.

Looking on that particular initiative and others in the Bureau, looking upon the needs that we have in America, Mr. Chairman, I think that what we should be looking for is a beefing up of the Bureau of Standards into perhaps an institute of technology. Rather than just testing something to see whether it is safe we should test it not only from the safety standpoint and standards

standpoint, but from the commercialization standpoint. Then turning it over to the commercial market in America.

Recently, the President sent a 1,600-page "competitiveness proposal" to Congress. It called for many things, including more funding for basic scientific research. Yet at a time when this country has serious problems with both manufacturing and the commercialization of new discoveries, not one word of the President's package dealt with basic engineering research and technical services in these vital areas. The National Bureau of Standards, the Nation's premier laboratory to assist industry, was not even mentioned.

This administration has a skewed policy for civilian research and development. It places almost its entire emphasis on basic scientific research. Support for basic science is important, and I am sympathetic to proposals to boost the budget of the National Science Foundation [NSF]. But this country's problem is not a lack of Nobel prizes. Our problem is keeping the Japanese from taking over every industry we have. I don't blame the Japanese; they work hard, and in science and technology, they have concentrated on research that helps them improve the quality and cost-effectiveness of their industry. I only wish that our Government was as much on the side of American business as their Government is on theirs. But instead this administration spends $50 million per year on civilian basic research in manufacturing, while, in the same breath, proposing to build a $4.5 billion "atom-smasher" with no practical use to U.S. industries. What kind of priorities does that reflect? We also know the budget constraints that the Federal Government faces, but where is the balance in current civilian research spending?

The administration's policies towards the National Bureau of Standards [NBS] and other technology programs of the Commerce Department are striking examples of the administration's wrongheaded priorities. NBS performs vital engineering research and provides the technical services that American industry needs to improve quality control, manufacturing, and the commercialization of new scientific discoveries. They provide the basic tools American industry needs. Yet look at the Bureau's recent budget history. In fiscal year 1982 appropriations totaled $120.3 million; in fiscal year 1987 they total $122 million. During the past few years, while the world has seen a revolution in manufacturing technology and entire new industries such as biotechnology and fiber optics have emerged, the Bureau's budget has not even kept up with inflation. What kind of priorities do these budget numbers reflect?

In addition, the administration proposed in 1985, and then again last year, to abolish the only technology and productivity policy office in the executive branch—the Office of Productivity, Technology, and Innovation [OPTI] located in the Commerce Department. This was first proposed in January 1985, the exact month the President's own Commission on Industrial Competitiveness dramatically summarized the problems we face in the new world economy. Frankly, OPTI has not been everything it should be; it is a pale version of what Congress intended when we passed technology legislation in 1980. But it has served some useful functions, including helping this committee write last year's Federal Technology

Transfer Act. Why the administration would propose its elimination is beyond me.

This year the administration proposes to keep OPTI, albeit with major cuts. It even proposes budget increases for the Bureau. Yet most of those NBS increases are for adjustments to base; net increases in programs total only $2.8 million.

In addition to these competitiveness-related matters, the Office of Management and Budget continues to push major cuts in the two Bureau units which do the most to help public safety—the Center for Fire Research and the Center for Building Technology. Apparently, OMB doesn't care that the United States has one of the highest fire death rates in the world or that 37 States are subject to earthquakes and need technical advice on how to make their buildings more quake-resistant.

It is time that we debated this administration's science and technology policies openly. And it's time that we take steps to ensure that the taxpayer's huge investment in civilian research helps American industry keep our economy strong and our standard of living high.

I wish I could stay with the committee longer this morning, but we have another important matter before the Defense Appropriations Committee.

But I do appreciate this chance to say a word and want to welcome Dr. Ambler and his associates and commend him on the fine job they are doing over there.

OPENING STATEMENT BY SENATOR RIEGLE

Senator RIEGLE. Thank you, Mr. Chairman. I think your statement is a most significant one, as the chairman of the full committee, in terms of the vision that you have with respect to consolidating and strengthening some of our activities in terms of forward technology and applied technology.

I know that I certainly share your view that we need to make a surge, as a Nation. We have a lot of competent people who have done a lot of good work. We ought to find a way to work off that potential more fully than we have.

So, our hearings today will be important in this respect.

I am going to make other additional opening comments, and then, when I am finished, I will call on Senator Rockefeller for his opening comments.

Our purpose in meeting today is to examine the operations and programs of the Department of Commerce which fall under the jurisdiction of this subcommittee, which are: the National Bureau of Standards; the National Technical Information Service; the Office of Productivity, Technology, and Innovation; and the new Japanese Technical Literature Program, which is of great interest to Senator Rockefeller particularly.

In many ways, these programs are not well known outside of the scientific or technical communities. Perhaps the best known is the National Bureau of Standards, which has had a major role in the development of manufacturing techniques and in the establishment of testing and measurement standards that are essential to modern production methods.

The Nationa' Bureau of Standards has utilized joint industry and government participation to construct a "factory of the future." NBS, perhaps more than any other single Federal agency, has brought the best minds of industry together with those in government to identify methods and processes that could be employed in the future.

I know, for example, that the U.S. auto industry has been involved in a number of NBS programs, especially in the area of high temperature ceramics.

In the last few years, the budget for this agency has not reflected the potential contribution that NBS could make to industrial competitiveness.

I note that the administration has requested a 13 percent increase for fiscal year 1988, and yet some very important programs are being reduced—those in the fire and building research areas.

One thing that we hope to accomplish today is a better understanding of the priorities of the agency within a very tight funding envelope.

A second agency that we will review today is the Office of Productivity, Technology and Innovation. This agency, in my view, has the potential to become a powerful voice in the government identifying which of our industries have become targets of foreign efforts and what the appropriate public and private actions might be to maintain technological leadership in a particular industry.

In a real sense, OPTI could coordinate the efforts of not only the Department of Commerce but of industry as well by tapping into resources throughout the government and in the academic community.

The administration has proposed the elimination of this agency in the past and this year proposes a major reduction in staff and activities. We have the Director of OPTI with us today, and I will be interested in learning about the administration's program in this area.

Finally, we will review the operations of the National Technical Information Service. This agency is responsible for acquiring and distributing domestic and foreign technical literature to U.S. industry. This is a service that could be of tremendous benefit to our competitive position in the world, since information is the first step toward product development and innovation.

The administration has proposed the contracting out of NTIS programs to the private sector. We will discuss this plan today. But I must state that I have received a number of inquiries from libraries in Michigan regarding this proposal and the effect that the plan would have on their operations.

Beyond that, most elements of NTIS are, in fact, self-supporting. So it is difficult to see where the public gain would arise from the contracting arrangement.

The hearing today should provide all members with a better understanding of the operations of these agencies.

There is an effort underway in the Congress to enhance the competitive position of the United States in the industrial area. These agencies can play an important role in this effort, and one focus of the hearing will be to see what steps we can take to improve and

expand these agencies and to incorporate them more effectively in our overall competitiveness efforts.

Senator Rockefeller.

OPENING STATEMENT BY SENATOR ROCKEFELLER

Senator ROCKEFELLER. Thank you, Mr. Chairman.

I am a little bit caught in a bind of my own this morning. We have a trade meeting in Finance, and I am going to have to go back and forth.

But I want to say a couple of things before you begin, Dr. Ambler.

First, I am a great fan of your organization, and sometimes I wish that it had been given a name that was more communicative to Americans so that they could understand all that you are doing.

We need to have a fast organization in this country in terms of basic engineering and research. If there is anything that we have learned from the Japanese, it is that they can take basic innovation and turn it into manufacturing processing quickly.

I went to a breakfast this morning where it was pointed out that we have many Nobel winners in sciences, but what we need is a stronger concentration on the engineering aspect, at which you are very, very good. In fact, I wish that more Americans could go to your institution to see the Ph.D.'s at work and understand the vibrancy and the relevancy of what your institution does in terms of making this country more competitive.

That is a sluch word, or a slosh word or a mush word these days. But, of course, in reality it is not. It is the whole future of our country.

I fail to know, Mr. Chairman, whether there is an agency of government that is more directly related to our competitive tenacity and position in the 21st century than your own.

So, I applaud you for what you are doing.

I agree with the Chairman that the increase the administration has given to you is deceptive, in a way, because they have cut down on some of your programs and have not allowed you what we would like to give you.

The National Science Foundation is working with our engineering research centers. Well, your whole philosophy, as I understand it, at the National Bureau of Standards is the fundamental relationship between science and industry and how that can be enhanced, this is something that we do not do in America very well, for whatever reason. The people who invent, invent. The people who manufacture, manufacture. And the two shall never talk. And we lose our competitive position.

You are doing the manufacturing at your automated manufacturing research facility, getting different robots to work together in a computer integrated facility. This is going to define what robot controlled factories are in the future. You are doing that. You are looking at that now. Nobody knows it, but you are, and it is important for our country.

You are working on advanced materials, as the Japanese certainly are. I know, Mr. Chairman, in a number of our industries in West Virginia, such as Huntington Alloys and Weirton Steel, they

are working with them—on tubing for nuclear power plants in the case of Huntington Alloys. The work of the National Bureau of Standards is basic to what they are doing. Also there is work on the internal structure and stability of metals. You are working, again, with a major industry there in our State. People do not know that, but you are, working with Weirton Steel, which is the largest ESOP in America, an extraordinary industrial innovation. You are working with them to determine the internal temperatures of steel and how to measure that more effectively.

As far as I can understand, you are a superb and cost-effective agency doing superb work for this country and yet remain fundamentally unrecognized.

I think the Chairman of this subcommittee and I and others are tired of your having to fight year in and year out for your budget. I agree with the chairman of the subcommittee that the Centers for Building Technology and Fire Research have to stay. Nobody else does that. But you do.

I will point out, Mr. Chairman, that I am very interested in what will be said by these witnesses later on about the implementing of my Japanese translation bill. Obviously I am very concerned about that.

I have long said that the Japanese do not try to do everything all at once. They are a nation of incremental planners. They do little things which, as they accumulate, as they ripple out, a great tide of progress ensues. They understand that. They take the long view. We do not.

But you do. The fact that one of our subjects this morning is going to be the Japanese translation bill is important to me. It is a small step, Mr. Chairman, but it is a basic step in do we understand what it is the Japanese are doing in technology, or don't we? Are we willing through small expenditures of public money to do what the private sector has chosen not to do, and that is to translate Japanese technological journals and learn from them, learn from the Japanese. They produce 10,000 journals a year, and we read about 100 or 200 because they are not translated and Americans do not speak Japanese for the most part.

So I care very much about not only the National Bureau of Standards and about OPTI, the National Technical Information Service, and then specifically about the Japanese Technical Literature Act.

All of these things make this an important hearing, Mr. Chairman.

As always, I commend you for whatever you do.

[The statement follows:]

OPENING STATEMENT BY SENATOR ROCKEFELLER

Mr. Chairman, I am pleased to take part in this hearing on the technology programs of the Department of Commerce.

As a supporter of Gramm-Rudman-Hollings, I am well aware of the need to reduce our budget deficit. However, in the course of belt tightening, we must allot the necessary resources for sound investments. We will be failing the country's long-term needs if we do not support our technological infrastructure.

The Administration's proposed budgets for the four programs we are examining today is a clear-cut case of being "penny-wise and pound follish." Furthermore, it smacks of business-as-usual in a time that demands boldness. The Administration

has recommended a 14% increase in the Bureau's budget for FY 88—on its face this appears to be quite generous. However, this amounts to only a $3 million programmatic increase, for a program that has had level funding for over a decade. This is hardly a bold move.

The National Bureau of Standards is a critical bridge between basic science and and industry in that it provides the building blocks that make technology work.

For example:

In manufacturing—At the Automated Manufacturing Research Facility, NBS scientist study how to get different robots to work together in a computer-intergrated facility. This will be essential in our robot-controlled factories in the future.

In materials—There's a huge potential market in advanced materials and the Japenese are moving quickly to exploit this new industry. Currently, the major impediment to the commercialization of advanced materials is the problem of their reliability and performance. NBS scientists are working to overcome this obstacle.

For instance, Huntington Alloys of West Virginia is helping NBS develop a data base on the corrosion properties of materials. One product that Huntington Alloys produces is tubing for nuclear power plants. The NBS data base will help this company decide which alloys to use and how to combine them—thus ensuring a reliable product.

Huntington Alloys is also working with NBS and the American Society for Metals on a reasearch project that will be used to prodict the internal structure and stability of metals.

Weirton Steel of West Virginia is involved in the American Iron and Steel Institute's project with NBS. The Institute and NBS are involved in reasearch to better the internal temperature of steel. This will help Weirton Steel, and other steel manufacturers, determine whether their steel is consistent throughout and improve the manufacturing process.

The cold neutron research facility—Currently being installed at NBS, this is a unique national research facility availble nowhere else in the United States. Particularly in the advanced materials area, the slow speed of the cold neutrons allows scientists to see things within materials—like tiny cracks—that they could not ordinarily see.

It's well established that NBS is a superb cost-effective agency. This makes it particularly tiresome for the Administration to take us through the same fight each year: whether or not to slash the funding for the Centers for Building Technology and Fire Research.

It's time to move on from that fitht. The Building and Fire centers are important—we should fully fund them. But we must address the most important issue: what can Congres do to ensure that NBS is a top flight institution that enhances America's ability to complete in the world marketplace?

Mr. Chairman, I know that the Administration has recommended doubling the National Science Foundation's funding over the next 4 years. That's a wise investment in basic research and in our Nation's future. I would urge this committee to recommend a similar investment in the National Bureau of Standards. If we are serious about the need to move our basic research from the labs to industry—which the Japanese have done so successfully—we must adequately fund NBS.

Mr. Chairman, I also want to express my concern about the Department of Commerce's progress in implementing my Japanese translation bill which this committee reported last year and later became law.

I said at the time that this committee was considering this bill, and I continue to believe, that the Japanese approach to competition relies on the tireless pursuit of many smaller efforts, which eventually add up. I'm not suggesting that we forget the big picture. However, these small steps aid in our efforts to help American industry keep pace with Japan and other technologically advanced countries.

The Japanese translation bill is a small, but important step toward helping American industry keep up with Japanese technology—I will be vigilantly watching Commerce's action on this bill.

In sum, the four programs that we are considering today—the National Bureau of Standards, the Office of Productivity, Technology, and Innovation, the National Technical Innovation Service, and the Japanese Technical Literature Act—are essential building blocks in our efforts to ensure our Nation a solid economic present and future.

Senator RIEGLE. Thank you, Senator Rockefeller. I think your point about the work that is underway in the Finance Committee today on the trade issue is very relevant to our discussion here and also the fact that we have several things going on simultaneously.

We are also marking up the budget today in the Budget Committee.

So I think all members of our committee and subcommittee are caught between conflicting assignments in different buildings here on The Hill at the same time. So we will see members coming and going as they are able to be here.

Dr. Ambler, if you would, give us your statement. We will put your entire statement in the record. I would like to ask you to summarize it as best you can and be as pointed as you can in your remarks to us.

Let me suggest that you feel free to pull the microphone closer to you and move it around to suit your convenience.

STATEMENT OF DR. ERNEST AMBLER, DIRECTOR, NATIONAL BUREAU OF STANDARDS, ACCOMPANIED BY RAYMOND G. KAMMER, DEPUTY DIRECTOR

Dr. AMBLER. Thank you, Mr. Chairman and Senator Rockefeller.

I am pleased to appear before you today to request authorization of appropriations for the National Bureau of Standards for fiscal year 1988.

With me is the Deputy Director of the National Bureau of Standards, Mr. Kammer.

We are requesting for fiscal year 1988 $138.6 million, $16.6 million more than Congress appropriated for fiscal year 1987.

This is the first time since 1982 that we have requested any significant overall budget increase.

This request for a budget increase is coming at a very critical time. There is a pervasive national focus on U.S. competitiveness and technology is universally recognized as one of the very important factors affecting economic competition.

During the past several years, I have focused on providing the best leverage for our resources, limited by the need for budget constraint. Emerging technologies are the most likely to lead to innovative products and services and, therefore, should get the highest priority in attention and funding.

I think we at NBS have been doing an excellent job of identifying and pursuing these emerging technologies and the science that underlies them. I deeply appreciate your remarks, Mr. Chairman, and those of Senator Hollings and Senator Rockefeller, with respect to your appreciation of what the National Bureau of Standards has been doing along these lines.

I find that very gratifying because I think it is clear from what you said that you do understand the organization and the surrounding problems, if I may say so, extremely well.

It gives me double pleasure to be able to come before you to ask for an increase, although it is true that it has not happened for some time. At least it is happening now, and it is substantial.

We do provide a range of technical services, such as measurement standards, test methods and evaluated technical data on which U.S. industry relies for quality assurance of products and services, effective and efficient control of processes, and procedures for design and redesign of products.

Our job of providing these services to industry is becoming bigger all the time, not only because the technological requirements are growing in diversity and complexity, but, more importantly, because the earliest possible introduction of new technologies is becoming more and more critical as foreign competition intensifies.

I think it was Senator Rockefeller who alluded to the fact that the Japanese beat us to the punch. I think that is dead right. We have to learn how to do it faster.

We have made a start in a number of emerging technologies, such as biotechnology, advanced ceramics, lightwave metrology and polymer composites. We accomplished this primarily through congressionally approved redirection of our resources as well as by judicious use of our competence building funds, which are a budget line item.

At the same time, we have endeavored to provide the measurement services that are critically needed to sustain our more mature technologies. In these cases, cooperation and cost sharing between industry, other Government agencies, and academia are especially important, and in our experience, all sectors are responding favorably to many of the needs for cooperation and, in particular, have been very supportive of our own efforts at NBS.

The automation area provides an interesting case in point. With an early infusion of appropriated funds into our automated manufacturing research facility, the interest of industry and other Federal agencies, particularly the Defense Department, was sparked.

Construction of the AMRF was completed in December of last year, and the results are already gratifying.

Twenty companies have commercial adaptations of portions of the AMRF research and ten automation and robot performance standards have been adopted or are being considered as a result of our work.

With our help, ideas from the AMRF are now being implemented at Navy supported facilities in South Carolina and California. Senator Hollings referred to that. To further leverage this work, we have provided technical briefings and demonstrations from more than 5,000 industry managers and more than 40,000 manufacturing personnel have been able to be briefed through videotapes of the AMRF that we have produced.

The AMRF is by no means an isolated example of our successful cooperative interactions with industry and other organizations. We firmly believe that working cooperatively with industry on the front-end of technology development is, by far, the best way to assure that we are addressing the most critical problems and is the most effective means of technology transfer.

I could cite many more collaborations of this type. We currently have more than twenty of them going on throughout NBS.

Such collaborations are facilitated by the fact that each year more than 200 scientists and engineers from industry and about 700 guest researchers, primarily from universities, work at NBS. These researchers take home with them the technology that they help develop and, therefore, are able to implement it very quickly and effectively.

And yet, alongside this high level of activity in emerging technologies, NBS has performed its duties with respect to public interests.

For example, teams of NBS engineers were sent to Mexico City following the September 19, 1985 earthquake, and to San Juan, Puerto Rico, following the Dupont Plaza Hotel fire on December 31, 1986.

A copy of the statement by Dr. Jack Snell, who is the Director of our Center for Fire Research, on the NBS investigation of the Dupont Plaza Hotel fire is available. Mr. Chairman, I would like to offer that for inclusion in the record of this hearing.

Senator RIEGLE. It will be included.

Dr. AMBLER. Our budget request for fiscal year 1988 reflects the Bureau's key role of supporting industry by placing emphasis on further enhancing the U.S. competitive position.

We are requesting $3.5 million for process control and quality assurance projects which would permit the Bureau to develop advanced primary standards and measurement methods to increase industrial productivity and product quality.

The proposed increase of $1.5 million for high performance composites reflects the tremendous market potential for these materials, which offer advantages in strength, stiffness, corrosion resistance, manufacturing flexibility and critical materials conservation.

The proposed increase of $750,000 for bioprocess engineering would enable us to develop engineering measurement techniques and reference data to support biochemical manufacturing.

We are requesting $500,000 for lightwave measurement technology. With fiscal year 1987 funding provided by Congress, we began to extend work beyond the optical fibers work that we have begun through redirection of the kind that I mentioned earlier. We started extending that to other critical components of these systems, such as light sources and detectors. We now propose to move faster and to expand our work into optical couplers and modulators.

Our science and technology enterprise depends on the availability of reliable reference data. Scientists, engineers, and technicians need rapid access to accurate data on the properties of materials and the characteristics of things like chemical reactions. To help them effectively gather and use scientific and technical information, we are requesting an increase of $500,000 for a pilot program to produce selected computerized reference databases.

A substantial portion of the increase of our fiscal year 1988 budget proposal, $13.7 million, is for adjustments to our base budget. This primarily reflects the amount needed to maintain ongoing NBS programs at their current level in fiscal year 1988.

It includes funding for continued construction of the cold neutron research facility, which was funded, I am happy to say, last year. It includes employee pay increases and contribution to the new Federal Employees' Retirement System, as well as increases for communications, utilities, and other cost of living items.

It also includes funding for several safety-related modifications to NBS facilities.

A decrease of $3.9 million is included in the fiscal year 1988 budget, reflecting a proposed combination of the NBS Centers for Fire Research and Building Technology into a single Center for Fire and Building Safety Research at a funding level of $5 million. The Center would receive $5 million and continue NBS's efforts directly addressing health and safety, such as work on earthquake

hazards, structural safety engineering, studies on the toxicity of combustion products, and the computer modeling of smoke and fire spread.

Measurements, standards, test methods, and evaluated technical data—the areas NBS specializes in—must be viewed as an integral part of discussions about U.S. competitiveness. We know that these NBS contributions to technical research and support foster scientific and technical advances and improved products.

When Mr. Baldrige testified recently before this committee on the competitiveness issue, he stated that "measurement standards, test method, and data do not sound very critical when you are talking about national competitiveness." But he went on to say, "I can assure you it is the nuts and bolts details of how you make your product that determine how well it performs, its cost, and, ultimately, your success in the marketplace."

I believe, as he does, that there is no industry that could not improve its competitiveness by paying even more attention to the results from NBS research and activities and by taking advantage of our cooperative research programs.

Mr. Chairman, let me assure you that NBS stands ready to do everything we can to bolster the competitiveness of U.S. industry.

Thank you, Mr. Chairman. I would be glad to answer your questions.

[The statements follow:]

STATEMENT OF DR. ERNEST AMBLER, DIRECTOR, NATIONAL BUREAU OF STANDARDS

Mr. Chairman and Members of the Subcommittee: I am pleased to appear before you today to request the authorization of appropriations for the National Bureau of Standards (NBS) for Fiscal Year 1988.

Accompanying me today is the Deputy Director of NBS, Mr. Raymond G. Kammer.

For FY 1988, we are requesting 138.6 million dollars, 16.6 million dollars more than Congress appropriated for FY 1987. This is the first time since FY 1982 that we have requested any significant overall budget increase.

This budget increase comes at a very critical time. There is a pervasive focus on U.S. competitiveness, and technology has been identified as one very important factor affecting economic competition. Technology must be introduced rapidly and must find its way into products of competitive quality.

During the past several years, I have focused on providing the best leverage for our resources considering the need for budgetary constraint. Emerging technologies are most likely to lead to innovative products and services and, therefore, should get the highest priority in attention and funding. I think we at NBS have been doing an excellent job of identifying and pursuing these emerging technologies and the underlying science. Even so, we must remain sensitive to changes and opportunities in these areas.

NBS provides a range of technical services—such as measurement standards, test methods and evaluated technical data—on which U.S. industry relies for quality assurance of products and services, effective and efficient control of processes, and procedures for design and redesign of products. Our job of providing these services to industry is becoming bigger all the time, not only because the technological requirements are growing in diversity and complexity, but, more importantly, because the earliest possible introduction of new technologies is becoming more and more critical as foreign competition intensifies.

We have pursued support of emerging technologies such as biotechnology, advanced ceramics, lightwave metrology, and polymer composites. We accomplished this primarily through Congressionally approved redirection of our funding as well as by judicious use of our competence building funds. At the same time we are pursuing emerging technologies, we must also continue to provide the measurement services that are critically needed to sustain our more mature technologies. We must pay attention not only to the newer industries, we must also support existing

industries which must, in turn, retain, or in some cases, regain their competitive edge. In these cases, cooperation and cost sharing between industry, other government agencies, and academia are especially important, and, in our experience, all sectors are responding very favorably and have been very supportive of our efforts.

The automation area provides an interesting case-in-point. With an early infusion of funds into our automated manufacturing research facility (AMRF), the interest of industry and other federal agencies, particularly the Defense Department, was sparked. The result was a substantial amount of other agency research support, and donation of equipment and researchers from industry. These industry staff work side-by-side with our scientists to develop the sensors, interfaces, and systems concepts needed to domonstrate the factory of the future. To further leverage this work, we have provided technical briefings and domonstrations for more than 5000 industry managers and more than 40,000 manufacturing personnel have viewed overview tapes of the AMRF.

Construction of the AMRF was completed in December 1986 and the results are gratifying. Already, 20 companies have commercial adaptations of portions of AMRF research and 10 automation and robot performance standards have been adopted or are being considered as a result of our work. With our help, ideas from the AMFR now are being implemented at Navy-supported facilities in South Carolina and California.

The AMRF is by no means an isolated example of our successful cooperative interactions with industry and other organizations. We firmly believe that working with industry on the front-end of technology development is by far the best way to assure that we are addressing the most critical problems, and also provides the most effective means of technology transfer.

I could cite many more collaborations of this type. We currently have more than twenty of them going on throughout NBS. Such collaborations are facilitated by the fact that each year more than 200 scientists and engineers from industry and about 700 guest researchers, primarily from universities, work at NBS. These researchers take home with them the technology that they help develop and are therefore able to implement it quickly and effectively.

One collaboration that has recently gained much attention is the Center for Advanced Research in Biotechnology (CARB), a cooperative effort between the University of Maryland, Montgomery County and NBS. We saw CARB as a natural source of collaboration for us since we were already ramping up to develop the chemical and physical measurement technology needed to keep the U.S. ahead in the intensely competitive biotechnology arena. Through CARB, we will have access to specialized biological esxpertise and facilities. More importantly, since about one-third of CARB's research staff will be visiting industrial fellows, CARB will provide NBS with a unique means to transfer newly-developed technology to users.

One of our recent developments which has gained overwhelming industry attention is a new instrument for observing the magnetic structure of surfaces at very high magnifications. This instrument will help electronics and computer firms, among others, to develop smaller, faster, and higher-capacity magnetic information storage devices, such as recording media. We already have numerous industrial collaborations and the list is growing rapidly. One instrument company is getting ready to market a commercial version of the device.

We have made major contributions in the area of computer security. For example, computer security assistance from NBS has helped the banking industry and the Department of the Treasury to protect trillions of dollars of electronic financial transactions. Among our latest accomplishments is a test system for validating commercial devices that authenticate messages, an important security technique.

Our efforts in support of the highly competitive field of advanced ceramics are beginning to have major pay-offs. For example, we recently developed and patented a novel, low-temperature method to synthesize ceramic powders which should help overcome processing difficulties and defects for this high-technology material. Already, more than 1000 industrial and other organizations have contacted us about this process.

And yet, in spite of this high level of activity in emerging technologies, NBS has not neglected its duties with respect to the public interests. For example, following the September 19, 1985 Mexico City earthquake, a team of engineers and seismologists from our Center for Building Technology were sent to Mexico City to provide technical advice to the rescue effort and to assess structural damage.

Our principle findings include: ground motions in the area of severe damages were greatly amplified by deep, soft soil deposits; collapses and severe damages occurred in some structures that vibrated in resonance with ground motion at the site; the duration of strong shaking was much more than is anticipated in current

earthquake design practice; many buildings hammered adjacent buildiings as they swayed during the earthquake and damaged buildings that otherwise would performed well. Our technical report on the investigation contains recommendations for earthquake hazard reduction.

Investigators from our Center for Fire Research participated in the investigation of the 1986 New Year's Eve fire at the DuPont Plaza Hotel in San Juan, Puerto Rico. NBS scientists applied their computerized equations and models to enable them to elucidate the cause and, most importantly, the speed of propagation of the fire. They were able to quantify the spread and extent of the fire in detail with minute by minute timing. This allowed the recreation of events and thus aided the investigation. Had this model been used prior to the fire, appropriate prevention measures could have been implemented by the hotel management. A copy of a statement by Dr. Jack Snell, Director of our Center for Fire Research on the NBS investigation of the DuPont Plaza Hotel fire is offered for the record.

Our budget request for FY 1988 reflects the Bureau's key role of supporting industry by placing emphasis on further enhancing the U.S. competitive position.

We are requesting 3.5 million dollars for process control and quality assurance projects which would permit the Bureau to develop advanced primary standards and measurement methods to increase industrial productivity and product quality. These improved measurement capabilities will help plant engineers and operators to more directly monitor the production process and correct problems on the spot. Working standards in industry demand more accuracy than is now available through some of our services. By increasing our joint efforts the result will be higher quality products with fewer defects and rejects. Congress provided funding in both FY 1985 and 1986 for the first phases of work in this category. This year's request is for additional improvements identified as having a high priority by industrial and professional organizations.

The proposed increase of 1.5 million dollars for high-performance composites reflects the tremendous market potential for these materials which offer advantages in strength and stiffness, corrosion resistance, manufacturing flexibility, and critical materials conservation. The accomplishments of the aircraft "Voyager" offers a dramatic glimpse at the potential of composites. Its round-the-world flight would not have been possible without the availability of one of the new, advanced materials, a graphite fiber composite which comprised 90 percent of the Voyager's basic structure.

The United States is ahead in applying advanced composites to defense and aerospace needs, areas where cost and process efficiency are secondary to absolute performance requirements. But high scrap rates and possible failure during long-term performances are key technical barriers that limit the full commercial exploitation of these materials. Overcoming these barriers will require better information about the relationships between structural defects and the properties of the material. Our initiative would permit us to develop basic information and measurement methods needed in the area of polymer composites.

The proposed increase of 750 thousand dollars for bioprocess engineering would enable us to develop engineering measurement techniques and reference data to support biochemical manufacturing. Right now, the United States leads the world in genetic engineering and biological sciences, but we face stiff competition in extending this laboratory technology to the manufacturing plant. NBS has the opportunity to stimulate this developing industry by providing measurements, data, and models for scaling up biochemical processes. We plan to focus on improved design and control of bioreactors and chemical separations in order to improve product yield and quality. By providing this information, NBS will help American industry to accelerate the commercialization of bioproducts and penetrate faster the world biochemical market, projected to be in the 40–100 billion dollar range by the year 2000.

Lightwave measurement technology supports optical telecommunications where light and hair-thin glass filaments rather than electricity and copper wire are used to transmit information. Because of the advantages of high information-carrying capacity, attractive cost, and better immunity to electronic interference, the use of this technology for communications continues to grow, both in the United States and worldwide. The market is now estimated to be about 1.5 billion dollars per year, and it is advancing at a 20–25 percent rate annually.

The future of this emerging technology rests on R&D toward high-performance products, quality assurance during manufacturing, and compatibility among components. That is precisely what the NBS program increase of 500 thousand dollars aims to do. With the FY 1987 funding provided by Congress, we began to extend work beyond the optical fibers to other critical components of these systems—such

as light sources and detectors. We now propose to move faster and to expand our work into optical couplers and modulators.

Our science and technology enterprise depends on the availability of reliable reference data. Scientists, engineers and technicians need rapid access to accurate data on the properties of materials and the characteristics of chemical reactions. To help them to effectively gather and use scientific and technical information, we are requesting an increase of 500 thousand dollars for a pilot program to produce selected computerized reference databases. Building on our experience in computerizing reference data, the pilot effort will assess the costs of maintaining an up-to-date system and will determine the potential for maximum cost recovery through the sale and lease of data products.

A substantial portion of the increase in our FY 1988 proposal—13.7 million dollars—is for adjustments to our base budget. This primarily reflects the amount needed to maintain ongoing NBS programs at their current level in FY 1988. It includes funding for continued construction of the cold neutron research facility, employee pay increases and contributions to the new Federal Employee's Retirement System, as well as increases for communications, utilities, and other costs of living items.

It also includes funding for several safety-related modifications to NBS facilities.

A decrease of 3.9 million dollars is included in the FY 1988 budget, reflecting a proposed combination of the NBS Centers for Fire Research and Building Technology into a single center for fire and building safety research at a funding level of $5.0 million. This center will continue NBS' efforts directly addressing health and safety, such as work on earthquake hazards, structural safety engineering, studies on the toxicity of combustion products, and the computer modeling of smoke and fire spread.

Measurements, standards, test methods, and evaluated technical data—the areas NBS specializes in—must be viewed as integral parts of discussions about U.S. competitiveness. We know that these NBS contributions to technical research and support foster scientific and technical advances and improved products.

As Secretary of Commerce Baldrige testified recently before this Committee on the competitiveness issue, while ". . . measurement standards, test methods, and data do not sound very critical when you are talking about national competitiveness . . . it is the nuts and bolts details of how you make your product that determine how well it performs, its cost, and, ultimately, your success in the marketplace." I believe, as he does, there is no industry that could not improve its competitiveness by paying even more attention to the results from NBS research and activities and taking advantage of our cooperative research programs.

Mr. Chairman, let me assure you NBS stands ready to do every thing we can to bolster the competitiveness of U.S. industry.

I shall be glad to answer any questions you may have.

STATEMENT OF JACK E. SNELL, DIRECTOR, CENTER FOR FIRE RESEARCH, NATIONAL ENGINEERING LABORATORY, NATIONAL BUREAU OF STANDARDS

Mr. Chairman, my name is Jack Snell. I am the Director of the Center for Fire Research (CFR) of the National Bureau of Standards. I appreciate the opportunity to appear before this Committee today to discuss the problem of life safety from fire, in particular hotel fires. One would hope that by now as a nation we would have our fire safety act together so that calamities like large loss hotel fires were a thing of the past, and the United States would no longer continue to post one of the worst fire death records in the world. Unfortunately, that is not the case. Even though we are still gripped by the horror of the Dupont Plaza Hotel fire, I submit that the American public has no better idea of the hazard to fire they face everyday in homes or elsewhere in hotels etc., than did the unsuspecting victims of this latest disaster. Why is this true? What can be done to change these grim realities?

These awful conditions continue for two reasons: first, people lack the tools they need to measure fire safety. For example, how can we tell how well a fire protection system will work if we don't have means to measure its performance? Tremendous strides have been made in measurement of fire risk, hazard and fire safety. These advances have launched a revolution in how fire is thought about, planned for, and confronted. The new measures now becoming available are making it possible to measure fire safety quantitatively, and to develop, "try out," or "practice" strategies for improving fire safety. Secondly, people lack the education and motivation needed. One is not likely to avoid a danger he is not aware of or does not comprehend. These new measures can help open the public's mind to greater awareness of

the hazards of fire and increase their motivation and ability to reduce fire risks and losses.

I would like to address hotels and fire in general, our role in the Dupont Plaza hotel fire investigation, the application of our tools to that fire, and conclude with a few recommendations.

HOTELS AND FIRE

There is something uniquely terrifying about a hotel fire, and that have been far too many of them. This may be because of the strangeness of the surroundings to the hotel guest, the isolation and lack of timely information about what is happening or what to do in a fire emergency, or some combination of these and other factors. Surely, the perceptions and attitudes as well as the "fire safety" knowledge of hotel occupants are as important to their ultimate safety as factors relating to the design or fire protection features of hotels. For example, the investigation report of one such fire reads as follows:

"The loss of 119 lives and the injury of 90 persons . . . is essentially the effect of over-confidence in a type of structure for a great many years described as 'fireproof' by many engineers and believed to be so by the public."

"The screams of the . . . occupants and the dull thud of bodies hurtling to (the street) should eliminate for all time the illusion that this and other buildings . . . are secure against all perils to life safety without adequate safeguards. . . ."

These statements appeared in the NFPA report of the Winecoff Hotel disaster of December 7, 1946, thirty years ago. Too many people still think they are safe in buildings that are made of non-combustible construction materials. Similarly, frequently, fire investigation reports cite victim's apparent lack of knowledge of available escape routes as significant factors in loss of life. We need to do a better job of communicating fire safety information.

In the excerpt of the Winecoff hotel fire report cited above, the "safeguards" referred to were for combustible interior finish and contents, i.e., furniture and furnishings. The fire hazards of highly combustible interior finishes have been greatly reduced, however, the fire hazards of hotel contents may in fact even be greater now because of the relatively high energy release rates of many modern materials used in them. Major hotel fires in just this decade include the MGM Grand in Las Vegas which was followed closely by the Las Vegas Hilton fire, the Westchase Hilton fire in Dallas, the Stouffers Inn in New York, and now the Dupont Plaza fire in San Juan, Puerto Rico. Highly combustible contents were clearly important factors in the magnitude of loss for each of these fires. Reduction of the hazards of combustible contents remains a major piece of unfinished business in improving hotel and home fire safety.

Now, as in the past, the typical pattern of response to a major loss fire is the same—a flurry of intensive media coverage, public outrage, and investigations and hearings leading to the identification of a "cause," perpetrator, or fault and resulting in new codes or standards provisions that ostensibly assure the public "that fire won't ever happen again." And, even though that identical fire probably won't recur, others do. Why? Simply because we lack tools that can be used to measure or evaluate the "safety" of a particular design, material, building, fire protection system, personal escape plan or even attitude or perception. For example, a concrete hotel may well not burn down, nonetheless it can still be a "deathtrap." This has been "proved" by the MGM Grand and Dupont Plaza hotel fires to name just two. (The MGM Grand is now considered by many as one of the "safest" hotels in the country as a result of the extensive retrofit of it following the fire in November 1980.) Similarly, a hotel can have sprinklers, but if they are not in the right place, it can be a "deathtrap." For example, this was the case with the MGM Grand, and Stouffers Inn fires. It is not always easy or obvious to tell whether a building is "fire safe." Fire safety depends on many factors, including, of course, the vast number of fire scenarios that are possible.

What is needed is a means to evaluate a hotel for all the many types of fire it may be subjected to, and to evaluate the likely behaviors, and fate of, the occupants. More precise means are needed for determining the sequences of events that occurred in a fire incident. We need to determine what "would have" happened with various alternatives, e.g., better materials or compartmentation, early warning, suppression systems, etc. What I am suggesting is that we need methods to simulate the performance of a building under assumed conditions of fire, methods like those routinely used, for example by airline pilots to "practice" in-flight emergencies safely on ground-based computerized simulators. Before going into detail on this

however, first let me say a few additional words about the importance of hotels in the context of the overall fire problem.

Hotels and motels represent just the tip of the iceberg of the U.S. fire problem, accounting for only 1.3% of the total fire deaths according to the National Fire Protection Association. However, it is crucial not to become complacent in view of such statistics. Hotels are important because of the public's perception and expectation that they should be safe and secure in them. Hotels are important because they present a large number of potential sources of fire—laundry, kitchens and storage rooms, restaurants, night clubs, convention centers, shops or commercial spaces, etc. in addition to the occupant rooms. Hotels are important because they often present large concentrations of people to any fire incident that may occur in them. They are also important because too often they are the target of negligence, carelessness, arson, and, increasingly, exposure to terrorist attack. Finally, hotels are important because new fire safety practices and technologies introduced in hotels ultimately find their way into homes. Lessons learned about hotel fire safety can have profound impacts on the rest of the fire problem.

THE DUPONT PLAZA HOTEL FIRE: AN ENGINEERING ANALYSIS

CFR staff have been involved in two aspects of the aftermath of the Dupont Plaza hotel fire. Two of our staff—Dr. James Quintiere, head of the CFR Fire Science and Engineering Division and Mr. Harold Nelson who is a recent past-president of the Society of Fire Protection Engineers—joined the on-site investigation on the fourth day following the fire. These men, along with investigators from the United States Fire Administration (USFA) and a team from the National Fire Protection Association (NFPA) participated in the investigation directed by the Bureau of Alcohol, Tobacco and Firearms (BATF). The coordination of this effort by the BATF and the cooperation among these professionals was exemplary. During the day, each specialist went about his own work. At night, the group assembled and placed together what each had learned during the day into what soon became a fairly clear picture of what happened. In particular, Nelson and Quintiere had at their disposal—on pocket and portable, lap size, microcomputers—recently developed fire models and engineering equations which they used to calculate the various stages of the fire's development. This was a precedent-setting application of these models on the scene of an active fire investigation.

I served on the Commission on Fire Safety at the request of the Governor of the Commonwealth of Puerto Rico. The Commission was co-chaired by Clyde Bragdon, Administrator of the U.S. Fire Administration and Rual Gandara the distinguished first chief of the Fire Service of Puerto Rico. The Commission report will be released soon. I will focus my remarks on the application of scientific and engineering research to improving hotel fire safety.

As you pointed out in your letter of invitation Mr. Chairman, the criminal investigation of this fire is still in progress and prevents me from discussing the details of ignition or other factors that might impact on the criminal investigation. My remarks will address our estimates of the development of hazards based on generally available engineering data.

In the late afternoon of the last day of 1986, a fire of devastating intensity swept through the lower floors of the Dupont Plaza Hotel in Puerto Rico, killing 96 people. In some respects, this fire seemed remarkably similar to the MGM Grand Hotel fire of December 21, 1980, in which 86 persons died. However, nearly all of the deaths in the Dupont Plaza fire were on the second floor and caused by heat and flames in marked contrast to the MGM Grand fire in which fatalities resulted from smoke inhalation involving persons mostly remote from the fire in their rooms or corridors many levels above the fire. In the Dupont Plaza fire, about 200 persons trapped on the floors above the fire apparently were able to tolerate the smoke while awaiting escape or rescue as the fire many floors below burned for several hours.

The NBS contribution to the BATF-USFA-CFR investigation report of this fire is based on a somewhat more detailed analysis we have refined over the last several weeks and which will be published by NBS as a separate black up report. I would like to summarize it briefly for you. (The complete NBS report will be submitted for the record when it is available, if you so desire.) I must emphasize that this anlaysis is based on how we believe the fire behaved in this particular building configuration. It is not based on the burning properties of the specific materials or products that were involved; only generic properties were used.

Figure 1 is a simplified elevation of the hotel viewed from the North. The fire was assumed to originate on a large pile of cartons of new furniture depicted in this figure by an "x" in the south ballroom. The south ballroom is under the balcony

and behind a set of removable partitions which separated it from the much larger north ballroom. Smoke began to fill both the 10-foot high south ballroom and flowed into the main 21-foot high north ballroom as the fire continued to progress in the cartons. This is illustrated by arrow 1.

Ballroom doors leading to the foyer, which contained the main staircase to the lobby, and outside were opened during this period.

As the smoke filled the ballrooms, it is estimated to have emerged into the foyer at approximately 5 minutes. This, we believe, was the first general indication of fire to the occupants of the lobby.

About 5 minutes later, we estimate flashover occurred in the south ballroom, involving large portions of the combustible floor and wall coverings. The window partitions to the foyer broke and a large quantity of smoke and flames were released into the foyer (arrow 2).

In roughly 40 seconds, a deep hot smoke front traversed the lobby area forcing the occupants to flee (arrow 3).

During these last few minutes, people in the casino became aware of the fire, but now those remaining had their only exits blocked by the dense, black smoke in the lobby.

Two minutes later, the exposed wood deck roof of the foyer became involved in fire and the extended flames broke the glass partitions to the casino (arrow 4). This sent a deep front of fuel rich smoke and flames across the casino. This front probably ignited most of the combustibles in the casino in the next minute. Occupants were hopelessly trapped. This is now approximately 12 minutes from the initial development of the fire. That is all the time we estimate it took for this tragedy to occur.

The conditions leading to the rapid spread and growth of this fire had little if anything to do with the allegation the fire was intentionally set. The outcome resulted from the design, materials, fire protection devices and systems of the hotel, and from the training, attitudes and perceptions of the people involved.

Figure 1

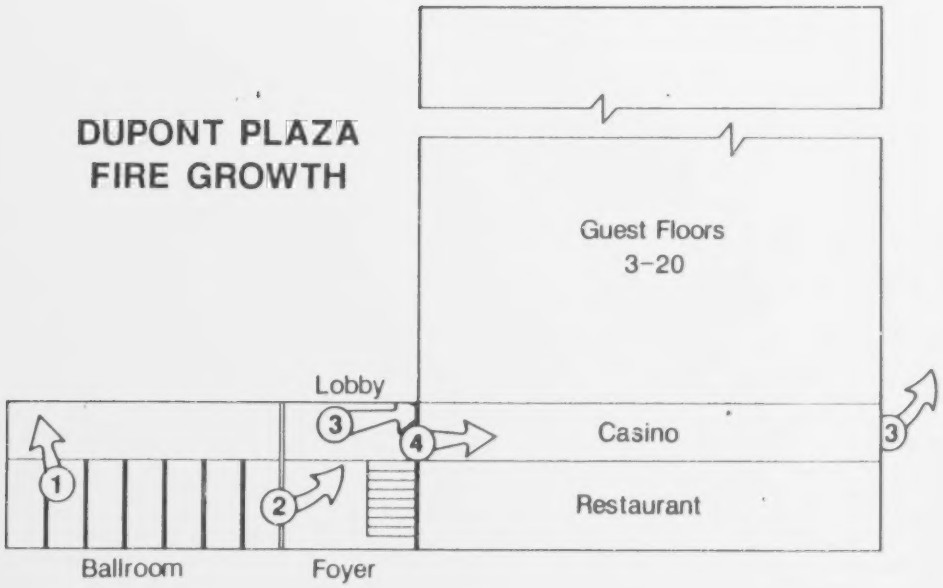
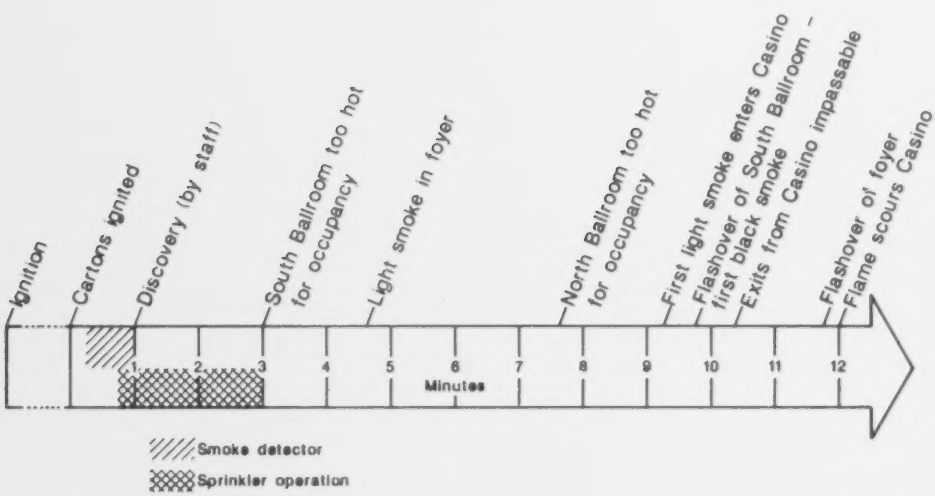


Figure 2

Estimated Times of Events



We have applied the same equations and models used to predict the course of this fire, to estimate the possible impact alternative fire protection devices, or systems may have had, specifically, smoke detectors for early warning, fire sprinkler protection in the ballrooms, foyer, and casino; and fire resistant materials for the partitions, and the wall and floor coverings in these spaces.

The response of a sprinkler head depends on the particular style of head and its position relative to the fire. Our analysis looked at the whole range. A modern, quick response head located directly above the fire would have been expected to go off in about 45 seconds after the cartons started to burn. At this time, the flame would have only been about three feet tall and there would have been very little rise in the smoke temperature. If, on the other hand, a traditional sprinkler head had been in a position about ten feet away, probably the slowest response we should expect, the head would have gone off at about three minutes. While this is a comparatively long time, it would have occurred at just about the time when the flames from the fire started to lick the ten feet high ceiling and the smoke layer had filled to about two feet down from the ceiling and its temperature had risen to about 265 °F. This would certainly be an uncomfortable place to be but not yet fatal. The hotel had a good water supply and an operating sprinkler head would have probably extinguished, or at least controlled this fire.

Smoke detectors would have operated more quickly. If one had been located directly above the fire, it would have gone off in about fifteen seconds after the flame got established on the cartons. At this time that flame would probably have only been five or six inches tall. If a smoke detector had been located near the far end of the room, say as much as forty feet from the point of fire initiation, it would have been another forty-five or fifty seconds until the detector operated. Of course, detectors only send alarms. Their worth depends entirely on how people respond to them.

Many modern building codes would require that the wall between the south ballroom and the foyer have at least a one-hour fire resistance. Had this been present, the fire would not have broken out into the foyer. There would, of course, have been serious damage inside the ballroom complex and flow of hot smoke and gas into the kitchen service corridor, but probably little threat to persons in the lobby or casino.

Had the partition between the north and south ballrooms been of a substantial construction, i.e., a fire-rated partition, the time to flashover would have been greatly stretched out; in fact, with no doors open flashover most likely would not have occurred.

The number of "what if" predictions that could be made is almost as endless as the questions that can be asked. Figure 2 summarizes our engineering estimates. This provides a framework for addressing such "what-if" questions. In some instances, we can now make reasonable engineering predictions, others would require extensive testing and experimentation. One example of the latter would be the contribution of the fabric wall covering material used in both ballrooms. A series of tests on this material and full scale tests of the stacked cartons of furniture burned would be needed to resolve this issue.

These analyses make use of tools for measuring the ignitability, flammability, toxicity, etc., of materials or contents; for quantification of the hazards to life of fire; and for prediction of the outcome of a fire. We have demonstrated how they can play a crucial role in addressing key issues concerning hotel and residential fire safety. Further, think about the impact computer models have had in aviation. It is common today to literally design and fly an airplane on a computer. In fact many of us, even non-pilots, have used personal computers to take the "controls" of airplanes from "Piper Cub" to a supersonic jet fighter on realistic flight simulators using software available for less than $40. Such realistic simulations are possible because there is sufficient knowledge of aeronautical engineering to predict aircraft performance and thus produce such realistic software. Professional pilots routinely use somewhat more sophisticated simulators to experience "safely" many in-flight hazards so they can learn how to survive them should they occur in reality. Until recently there simply wasn't sufficient knowledge about fire to do the same sort of thing in this field.

Last August, we introduced a hazard assessment method to industry under the name, HAZARD I. This method calculates the hazard to people from a specified fire in a specified building. A report describing the method is now in final review and the software, which comes on a set of six 5¼ inch floppy discs is going through the final stages of an elaborate debugging process. We expect this system to be available this spring. The HAZARD I system is being released at this time as a prototype system for pilot study use and for industry review and comment. Meanwhile we are proceeding with a number of important enhancements.

SUMMARY AND RECOMMENDATIONS

There is no question about it, technologies exist to make hotels and homes fire safe. The problem is fire safety involves trade-offs, trade-offs between cost, function or comfort, and safety. Disasters result when either the risks of fire were not perceived correctly and/or these trade-offs weren't assessed properly. Obviously, it is difficult to do these things, and particularly so in the absence of adequate measurement tools.

This tragedy, like many before it, demonstrates the fact that most people have inadequate knowledge of fire risks and hazards, thus aren't motivated to act appropriately.

People lack means to make the trade-offs of safety-cost-function required to reduce their risks to acceptable levels.

Also, it confirms that available technologies either are too costly or are perceived as such by many hotel operators. (For example, the Dupont Plaza is not the only unsprinklered hotel. It has been estimated that as many as 95% of hotels and motels are not protected by sprinklers.)

The type of tools NBS is producing can provide bases for powerful new means to address these needs. For example, these tools can provide the basis for simulators and related materials to permit people to evaluate how well various combinations of fire protection technologies will work, to enable quantitative evaluation of fire safety tarde-offs, and to stimulate and guide development of more effective and affordable technologies for fire protection. NBS is working with others in the fire protection community to take these steps.

The public, state and local governments and industry can benefit from further analysis this year of the Dupont Plaza hotel fire. By providing answers to many "what-if" questions, and estimates of the impacts of changes in codes and practices proposed as a result of it much can be learned.

NBS scientists successfully applied their equations and models in the Dupont Plaza fire. This not only affirms that the CFR research program is on the right track, but also suggests this approach may become a powerful new aspect of future fire investigations. Specifically, the use of a multi-discipline on-site investigation team, including fire scientists and engineers; use of computer-based models and engineering tools for predicting fire and its consequences; and complementary small and full scale tests to verify computer-based fire "re-creations."

Senator RIEGLE. Thank you, Dr. Ambler.

Senator Pressler, do you have any opening statement or questions? After you, I will call on Senator Gore for his questions.

OPENING STATEMENT BY SENATOR PRESSLER

Senator PRESSLER. Yes, I do, thank you.

As the new ranking member of this Science Subcommittee, I look forward very much to learning about the programs of the National Bureau of Standards, OPTI, and NTIS, and the role these agencies have in aiding our economy.

These programs constitute the Federal Government's efforts to help business use the latest technology in the design of their products.

NBS's work in standards results in the widespread use of products. OPTI's work helps business become aware of possible ways of increasing productivity; while NTIS makes available to business over 1.6 million scientific and technical reports of Federal agencies and foreign governments.

Oddly enough, even though the administration professes a desire to increase this country's competitiveness, it now proposes to drastically reduce the staff at OPTI and privatize NTIS.

At this morning's hearing, I would like to explore with our witnesses any comments they may have regarding these agencies and NBS's alternative pay system. This system, which does not have to

go into effect until January 1, 1988, recognizes an important principle; good research requires good people.

The record of Federal laboratories, however, shows that they do not pay salaries that can compete with private industry or universities in attracting or retaining the best talent.

Starting salaries in many government jobs run about $10,000 behind those of private industry. In some fields, such as computer science and electrical engineering, the difference is even greater.

At the top end, senior executive officers in the Federal Government make $72,300, while their industrial counterparts make between $107,000 and $164,000.

Mr. Chairman, this is something that I have pointed out in our NASA hearings and in some other Government agency hearings. We can only compete and have the kind of people we need and reward the people who do good work if we pay a salary that is somewhat competitive.

As a result, many of our nation's brightest young people and the Government's finest scientists are choosing to work for industrial laboratories and universities.

If Congress is going to support Federal laboratories, it cannot continue to neglect the scientists working there. New ways of paying Government scientists and new ways of rewarding those who perform outstanding research should be examined. To do otherwise, we risk losing the valuable contributions that Federal laboratories make to our society.

Thank you, Mr. Chairman.

Senator RIEGLE. Thank you, Senator Pressler.

Senator Gore.

OPENING STATEMENT BY SENATOR GORE

Senator GORE. Thank you very much, Mr. Chairman.

Again, I want to congratulate you on this hearing and on your leadership of this subcommittee through a very large jurisdictional area.

I want to express my strong support for NBS and express the view that it has been underrecognized, underappreciated, and underfunded, and that its importance will continue to grow as we try to coordinate the various activities of the Federal Government and other aspects of our society to become more competitive in the world economy.

I am particularly supportive of efforts to which you have referred, in the areas of advanced ceramics and advanced fiber optics technology. But I must say that I am extremely disappointed in the proposed combination of the Center for Building Technology and the Center for Fire Research, coupled with a drastic 50 percent reduction in the funding for these extremely important activities.

I think it violates understandings that the administration had with the Congress during considerations of last year's budget proposal. It certainly runs contrary to the best advice and recommendations of the professional engineering and fire research societies throughout this country. We have the opportunity to save billions through better research in both of these areas. Engineers, archi-

tects, and other professionals involved in both of these areas understand it.

So it is beyond me why the Federal Government, or at least the individuals in charge of these programs in the Federal Government, do not seem to understand that.

As a member of this subcommittee, I will work with my colleagues on both sides of the aisle to try to reject your recommendation on that particular matter. But, as I said, overall I think we have to recognize how important this agency is. I look forward to working with you.

Thank you, Mr. Chairman.

Senator RIEGLE. Dr. Ambler, I want to make a comment at the outset. While the Bureau has done some very fine work and I think has labored in the shadows of a lot of the more exotic-seeming activities of the Federal Government, I think that is about to change. I do not suggest that it is going to change in a major way this year or next, but I think I can give you some great assurance that, by 1989, we are going to have a new emphasis and focus within the Executive Branch of government.

For one thing, we are going to have a new president, and I suspect that that president will be much more committed in a serious, hands-on way, to the issue of national competitiveness and the need for this country to make a real surge.

The trade deficit last year was $170 billion, as you know. And in virtually every category within the trade activity, we are faltering. Certainly in the manufacturing area; we imported more high technology items last year than we were able to export. In three of the 12 months, we imported more agricultural items. We actually are very close to having a deficit in the services account. But, certainly in the areas where technology applies, we are in real trouble, and all the yardsticks show that.

We are now the number one debtor nation in the world, as a result of the fact that trade is flowing the wrong way.

Just 2 weeks ago, we had a study group in the Defense Department report to the President—it was named by the President—and it reported that we are far behind the Japanese in semiconductors and they went so far as to recommend that we would have to consider major public subsidies to that industry to get ourselves back in the game in terms of computer chips and super-computers with respect to the challenges posed by the Japanese.

So, the country is in real difficulty in these areas.

We have all kinds of measurements of it. We had the Young Commission National Report on Competitiveness about 2 years ago. An exceptionally fine job was done with that, but it basically was tossed in the wastecan when it was brought back to the administration.

But I say, again, that is sort of the dark side of the story, namely, no real attention paid to technology and competitiveness. There is very little focused attention to try to move it at a faster rate and so forth.

Well, that is going to change.

So, I would say to you and to others who have been laboring in these areas of work to get ready because something is about to happen. I think when you see the change in command, you are

going to find that we are going to harness ourselves to an effort to make a national surge that is going to require everything that has been done and can be done within your area of work to help this country move ahead.

I think you will see much more effort to try to take and help the private sector with a number of the challenges that it faces, both fair and unfair, from abroad.

That is the good news. The bad news is that this languishing treatment that we have seen over a period of time will shortly be coming to an end. And then, everybody is really going to have to hitch up his socks because we are going to go at a pretty fast rate, in my view, and the country is going to need to make that kind of progress.

Having said that, let me ask you specifically, with respect to the semiconductor industry and the manufacturing problems that we have been hearing about there, this question.

Last year, the National Research Council reported that the Japanese are now ahead in seven critical emerging technologies for semiconductor research and production. I have mentioned these other studies out of the Defense Department and so forth.

We have had the heads of the major Silicon Valley companies come before the Banking Committee and tell us that they have been permanently damaged because they have been shut out of their fair share of foreign markets and they have not gotten the capital recovery they need to invest in new technology and research and so forth.

Where do we stand today in your view in that area?

How are we doing in terms of international competition in terms of the high technology semiconductor super computer area? Are we in trouble or are we making good progress in that area and can we count on a nice, strong future there?

Dr. AMBLER. The thing that we focus our attention on at the National Bureau of Standards is working on the technical problems that——

Senator RIEGLE. Let me stop you. I am not asking for what you are doing in the Bureau. I am asking you for a professional overview and assessment of what our competitive position is. Then later I want to get to the question of what the Bureau may or may not be doing about it.

I am asking for a different insight here, just so that you understand what I am driving at.

Dr. AMBLER. Yes, I understand.

I do not fancy myself always as the world's expert in this particular area. But you asked for my impressions.

My distinct impression is that we are losing ground. But there is nothing really new about that. We have been losing ground for years. It all started I think with transistor radios, and then it went to motor bikes, and now it is in integrated circuits and it is going to go to computers. All of the evidence shows that the Japanese have a way of going after things, whether it is always legitimate or not, in such a way that they succeed.

I think it is wonderful what you said earlier, that the Congress is going to take leadership in recognizing this, because I think that is what it requires. To me, it seems not only today, but it has seemed

this way for many years, that we were complacent, and to a large extent, we really still are.

It is all very well to be proud of many of the things that we have accomplished. But the economy is the thing that pays for everything. It pays for defense, it pays for social programs. If you are going to lose that, that is basic. This has terrified me for years.

I think there are no quick fixes. There are no gimmicks. We know that a lot of the things we have tried will not work, and a lot of the response has to come out of the private sector itself, with the government helping in any way it can.

Sure, I think there is tremendous cause for concern.

Senator RIEGLE. Well, let me ask you this as a followup.

In terms of watching the Japanese performance over the years—and we all marvel at the success that they have had—let's take the part of that that has to do with government in Japan. They are working with industry and helping to move things forward at the most rapid possible rate. If you compare the role that government—and they obviously have a different system—has played in facilitating those forward strides by Japanese industry, and you compare that to the role of government in helping American industry make corresponding strides, what kind of comparison do you see there?

Dr. AMBLER. Well, they have been very much more successful.

Senator RIEGLE. But have they been successful because they have put a lot more into it? I mean, why have they been more successful?

Dr. AMBLER. Well, I think we understand pretty well the way they do it. I mean, it is not very simple and there are a lot of complications that are particular to Japan, to Japanese culture. But I think we understand a lot of the things that go on there, the targeting and all of that, and how they sort of work together and yet compete.

Now, the thing is that the way they do it is such that we cannot immitate that here because we do not have that kind of system. We have to find our own way, with our own form of government and our own particular genius to do it. We don't know that yet, or so I really do not think.

It is true we have tried. The government has tried, in the past, a number of ways, going back, according to my recollection, to when Mr. Nixon was President. There were things tried then, and there were demonstration projects.

None of them worked very well. They did not work very well because it was a question of the government showing industry what to do, what to make. And that does not work.

You know, this notion of technology transfer, like moving furniture around—if you just move it to another room, it is not technology transfer. Technology transfer is not like that at all. It does not work that way. It works by people working together and cooperating from the very beginning.

I think we have to learn what is the American genius for being competitive and working together, not just the government, but academia and the whole country, working together toward a common aim.

It is not too clear.

One of the things I do not think is going to help, having been a bureaucrat for over 30 years, is dumping on the government for screwing things up. That probably has gotten to the point of diminishing returns. I do think a number of wonderful things have happened. Interest rates are down and there are many really very good things.

But if we want to tackle this problem, I think we have to turn around to the private sector and say why aren't you doing it, what is the problem, and what needs to be done to fix it.

I wish I knew what the answer to that is, but I do not.

Senator RIEGLE. We will come back to that in just a moment.

Senator Pressler.

Senator PRESSLER. Yes, Mr. Chairman. I have a line of questioning regarding services to small business.

Let me say, first of all, that I was late because we are having an Environment and Public Works Committee meeting on PCPs, and we have just had 16 of my towns have a very difficult time paying for a cleanup that the company was going to do, and they paid the company, and there was a bankruptcy, and so forth.

I am going to have to get back to that committee hearing.

This is a very important matter. One thing that concerns me—and I do not think it is any fault of yours, Dr. Ambler—is most of the information is used by big business because of the availability of computer hookups and our small businessmen sometimes just do not know what is available.

A recent report of the National Research Council found that small machine owners were very interested in the manufacturing programs of NBS. But large corporations tend to take greater advantage of NBS's research.

The small shop owner suggested that NBS consider developing programs specifically for small shops, that the information be presented in layman's terms, and that the program stress the potential impact manufacturing technology could have in meeting the needs of small machine shops.

Small shop owners believe a program of videotapes and visiting speakers at National Tooling & Machine Association chapter meetings would be the most effective way for disseminating NBS technology.

The question is does NBS have any plans to develop scientific programs for small business?

Dr. AMBLER. Yes. That is an extremely important point and one that we are thinking about more deeply than usual right now. Not the least reason being that small manufacturers contribute—I don't know what the figure is—at least 50 percent of the gross manufactured product. So they are extremely important. A lot of small businesses are very innovative ones, so it is very important.

Let me say, first, that we do work with small businesses and many of the precision instrument companies, of course, are small businesses. This is a thing in which we specialize. So we do do it to some extent.

But, by and large, your point is correct. What we do tends to flow more easily to the big companies than to the smaller ones. One of the problems is that there are many more smaller ones than there

are bigger ones and it is harder to deal on a one-on-one basis. In fact, it is practically impossible for us.

So what we are looking at are intermediaries. I think this is extremely important.

Now, in some ways, big companies can be intermediaries because the smaller companies are often suppliers. So they can affect the modernization or the automation of smaller industries. In fact, one way that we know it has occurred is through the standard that we worked on, the interim graphics exchange specification for CAD descriptions of computerized prismatic parts. If a big company goes to a supplier and says if you want to supply to me, you have to do it using these things, then it will work in that way. So the bigger companies can have that effect.

I think the thing that we feel will be more fruitful for us and for other people is to pay much more attention than we do to the State and local efforts. There are many of these now building up. Every State has one. The Ben Franklin one in Pennsylvania is one that springs to mind. That was an earlier successful one, and there are others.

There are other efforts, such as incubator projects, enterprise zones, a lot of State and local things starting.

I think it is by working with them and through them in some kind of cooperative way that we will be most effective. I do not think there is any way where we would have to reach to go individually.

Those are the lines along which we are thinking. We do not have any specific plans yet, but we are working on them.

Senator PRESSLER. I would like to have my staff meet with you and your staff to see if we can pursue some ideas along those lines.

If large companies can buy products from foreign firms, what incentives will they have to put pressure on small machine shops to adopt computer aided manufacturing?

Mr. KAMMER. Sir, if I could respond, most American companies make their selections based on quality and price. Of course, a local firm has some advantages of price, just because they are nearby, and because they speak the language and they can establish a relationship that you hope can last a long time.

If the smaller firms are not willing to adapt to the new technology, they, in effect, lose on quality.

We have seen a lot of instances in the automobile industry, for instance, where the large companies have been willing to educate the small companies. They have seen enough in it for themselves to carry forward. But it is not always the case.

I think a fair answer is that there is a problem there.

Dr. AMBLER. May I add to that, Senator.

On this general question of small business and this related automation question, there is an interesting observation, I think. If you are a small businessman and you want to install let's say a data processing system, say for your checkout. You are not too big, you have maybe a few stores, and you want it for your checkout, to handle your inventory, to handle your accounts, and so on, you can find pretty good consulting companies that will help you do that, you know, a turnkey operation. They will train your people—the whole thing. So it is available.

Now, if you were to say well, if it is available there, why isn't it available for the small manufacturer? There is a complete absence of these systems consultants in the area of automation. I think it would be very well to encourage people to enter that business and become consultants who will help the small manufacturer with his mechanical automation problems, rather than just his business systems.

Senator PRESSLER. I would like to organize a meeting with my staff and you and your staff on this whole issue of how we can get the small businesses more tuned-in in the future. I know that it is hard because many of them do not have sophisticated computer operators and so forth. I think it is something we need to work at.

Mr. Chairman, I have several more questions and am going to try to come back. I have 16 of my cities and REA's involved, and I want to be sure I get in some questions in the Environment and Public Works Committee on PCPs.

Senator RIEGLE. Very good, Senator Pressler. Thank you.

Those questions will be submitted to the witness.

Senator Rockefeller, I know that we need to get to Dr. Merrifield soon so that you are able to pose some questions that you would like to pose for him. But do you have anything for Dr. Ambler at this point?

Senator ROCKEFELLER. I do not, Mr. Chairman, except to make two observations.

One is that for the last 10 years, in constant dollars, Dr. Ambler's budget has remained exactly the same. Secondly, I would buttress an earlier point that I made of the 1,405 people who work at the National Bureau of Standards. Fifty percent of them, or 700 of them, are Ph.D.'s. They work in the national interest, and our question is do we use them sufficiently. That is, as you indicated, what we will be pushing for in this committee.

Senator RIEGLE. I thank you for those comments, Senator Rockefeller. I think it is very important to acknowledge the work of the people who are there because I think in almost every case people are working in the national interest at salary levels below what they otherwise might earn in the private sector. We appreciate and admire that work. We intend to make more use of it.

I just want to say, again, that I think a new day is coming with respect to the kind of national surge and competitive effort that we are going to have to make. So we are going to find ways to make far greater use of those resources and that effort and that infrastructure.

So I would ask people to be patient a little bit longer because there is going to be a changing of the guard here soon, and when there is, we are going to start moving again.

Let me indicate that any other questions that I and others have we are going to submit to you for the record, Dr. Ambler, and we thank you for testifying here today.

Dr. AMBLER. Thank you, sir.

[The following information was subsequently received for the record:]

Questions of Senator Riegle and the Answers

NBS response to changing technology

Question 1. Peter Cannon, one of the other witnesses at our March 17 hearing, made the important point that technologies now undergo fundamental changes every three years. This leads to two questions: (a) What work must the Bureau do to ensure that American industry has the up-to-date technical data and services it needs in this era of rapid change? (b) In which fields, in your judgment, should the Bureau concentrate in the next few years?

Answer. NBS must stay constantly alert to changes in science and technology. NBS scientists and engineers are at the cutting edge with research that uses cold neutrons from the NBS Research Reactor. NBS has been at the lead in making the Reactor's cold neutron source operational, and in proposing a Cold Neutron Facility to house a guide hall. NBS has been working with industry to fund work stations at the cold neutron source to provide industry and universities access to this unique research tool. Another major way NBS stays at the leading edge is through the NBS Technical Competence Program. The purpose of this Program is to provide NBS with the knowledge and skills necessary to maintain a leadership position in a constantly changing technological world. Through competence building NBS scientists and engineers are at the cutting edge of science and new emerging technologies. This enables NBS to build the capacity to contribute effectively to future national needs and goals. It has enabled NBS to develop staff expertise in areas as diverse as automated manufacturing, robotics, biochemistry, optoelectronics, cryoelectronics and surface physics. Many of these fundamental efforts have already had tangible effects on Bureau programs, and have contributed to the needs of industry. This program enables NBS scientists and engineers to identify new areas and pursue the research which is the basis for the technical data and services which industry needs to respond to rapid changes in technology and the marketplace. In this way, NBS efforts in new technologies not only support emerging industries, but also mature industries that need to apply new technologies to remain competitive.

Small business and the Bureau's work in automated manufacturing

Question 2. The Bureau's Automated Manufacturing Research Facility is an important project for making robots and other automated equipment work together, under central computer control. Many large companies work with the Bureau in this project. However, 100,000 small "job shops" form the backbone of American manufacturing. These small machine tool companies make 75 percent of the manufactured parts in this country and face strong competition from the Japanese. Your facility was not designed to help small business, but could the technology be adapted and then disseminated to help small companies learn the basics of how to automate and improve the quality and cost-effectiveness of their products? What actions would be required to accomplish this task?

Answer. NBS is addressing this challenge. We are seeking partners in the private sector both directly and through the economic development commissions of the several States to build integration facilities at the local level. These sites would provide demonstration of available technology suitable to the needs of the local small businesses. It would provide "incubator" facilities where small firms could share automated manufacturing facilities and learn the basics at greatly reduced capital risk. The facilities would also serve as training facilities, both at the vocational and community college level. One such facility is under construction in Charleston, S.C., using NBS technology (suitably adapted), an industrial consortium doing the work, with funding coming both from the Department of Defense and the South Carolina Research Authority.

NBS is working with interested industry sources to assemble, within the small machine shop operated by NBS for its own use, a model facility. This would be an automated manufacturing facility built of components that are commercially available and commercially supported today. Unlike the Automated Manufacturing Research Facility, it would not be a research facility but a hard-working job shop supporting NBS activities. Having such a facility, NBS would encourage small shops to duplicate or adapt it to their needs.

Progress in ceramics research

Question 3. I understand that in the last year you have developed a new test procedure to measure strength in ceramics. What is its value? And how much more research do we need before we can manufacture reliable, cost-effective ceramic products?

Answer. In the last year, research funded by both the DOC and the DOE has resulted in the development of a technique for directly and inexpensively measuring the tensile properties of ceramics. Typically, the bend strength of ceramics is measured and the tensile strength inferred from this datum. Designers, however, desire directly measured tensile properties for use in predicting component performance and the NBS developed test methodology provides this information in a cost effective way. We foresee wide spread industrial use of this measurement technique. When fully adopted by U.S. industry, this could result in cost savings of $4 to $5 million per year, as well as making the tensile test data widely available.

The current U.S. ceramics research effort, including both public and private funding is about $100M per year. While the public funding is directed toward research of general interest, private sector funding addresses the specific interests of individual companies. Assuming the current rate of technological development and the current level of public and private funding, we estimate that widespread introduction of ceramics will take at least 5 years.

MANUFACTURING SEMICONDUCTORS

Question 4. The semiconductor industry and its manufacturing problems have been in the news a great deal recently. Last year a National Research Council report entitled "Advanced Processing of Electronic Materials in the United States and Japan" concluded that the Japanese are now ahead in seven critical emerging technologies for semiconductor research and production. What measurement-related research and services are necessary in order to help United States industry regain its lead in semiconductor production?

Answer. Semiconductor manufacturing is a measurement-intensive business. It has been estimated that about one quarter of the cost of semiconductor manufacturing is in measurement. As device dimensions continue to shrink and chips become more and more complex, the demands of measurement technology increase. Better sensitivity, improved accuracy, and automation of the manufacturing process are all needs that must be met.

NBS has close working ties with the Electronic Industries Association, the Semiconductor Industry Association and its research consortium the Semiconductor Research Corporation, the Semiconductor Equipment and Materials Institute, and the American Society for Testing and Materials. These organizations and their member companies provide invaluable guidance in identifying measurement problems of the greatest significance to the industry and in the conduct of research to solve them.

NBS believes that measurement methods, data, and theoretical understanding need to be developed for the following:

Improved materials characterization for large-scale substrates;

Procedures for characterizing and controlling submicrometer lithography processes in an automated manufacturing environment;

Methods, materials, and optics for advanced optical and x-ray lithography;

Procedures to evaluate automatically material and process quality after each process step (e.g., lithography, etching, deposition);

Performance measurement methods for new equipment;

Measurements for low temperature (less than about 500 degrees celsius) processes;

Application of expert systems to control of automated manufacturing environments.

THE DUPONT PLAZA HOTEL FIRE

Question 5. On New Year's Eve, a fire broke out at the Dupont Plaza Hotel in Puerto Rico, killing 96 people. Researchers from your Center for Fire Research were part of the federal team that investigated that fire. What did your experts determine happened at the Dupont Plaza? How did the fire spread so quickly and kill so many? Does your analysis suggest that sprinkler systems would have saved most of those people? Would less flammable carpets and furniture have helped?

Answer. The National Bureau of Standards' researchers from the Center for Fire Research were part of the Federal team that investigated the Dupont Plaza Hotel fire in San Juan, Puerto Rico. They used computer-based fire models and equations to develop a detailed explanation of what happened after the ignition of this tragic fire that fits closely eyewitness accounts and other data from the site.

The fire developed rapidly on a shipment of new furniture still in the shipping cartons that was stored in the South Ballroom of the Hotel. The fire quickly spread across the corrugated cartons then fed on the dressers and sofas inside the cartons. The rapidly growing fire developed unnoticed because it was out of sight of most

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hotel occupants, no detector or sprinkler systems were installed in the hotel, and the fire alarm system was not operational. The fire resulted in so many deaths because there was nothing to halt or slow its growth or spread. Once the fire erupted from the ballroom by breaking out the glass wall to the foyer, it raced across the hotel lobby in approximately 40 seconds, blocking the exits of the Casino, where most of the victims were located. Within two minutes, the glass separating the foyer and the Casino broke out and flames swept across the Casino in about 20 seconds, trapping and killing the remaining occupants.

The same computer-based tools were used by NBS scientists Nelson and Quintiere to analyze a number of "what if" type questions. Undoubtedly, most, if not all of the deaths resulting from this fire would have been prevented if operational sprinklers had been installed in the ballrooms. The tragedy may have been averted if the hotel had working fire or smoke detectors, an operating alarm system, and a trained staff. Probably, the fire never would have spread from the ballrooms if the foyer walls had been made of fire rated construction instead of glass. Also, had less flammable furnishings been involved, the impact of this fire might have been reduced.

Dr. Jack Snell, Director of the Center for Fire Research served on the Commission on Fire Safety appointed by the Governor of Puerto Rico to review fire safety laws, regulation, codes, and the operations of the fire service. That Commission presented its report to the Governor of Puerto Rico on April 8, 1987. A copy of the executive summary is attached.

NBS RELATIONS WITH AMERICAN COMPANIES

Question 6. The National Conference of Standards Laboratories recommended in their testimony before the House that NBS (i) change the accounting system used to calculate fees for Bureau services and (ii) establish and maintain a systematic and vigorous outreach program? What is your response to these two recommendations?

Answer. On March 19, NBS officials and National Conference of Standards Laboratories (NCSL) officers met and discussed NCSL's recommendations. The misunderstanding regarding our accounting system has been cleared up, and NCSL officials are satisfied that our system is adequate for NBS needs.

QUESTIONS OF SENATOR ROCKEFELLER AND THE ANSWERS

FUNDING FOR NBS

Question. In 1982 the National Bureau of Standards received $120.3 million in appropriations. Five years later, in FY 1987, NBS received $122 million—less than a $2 million increase. For about a decade, taking inflation into account, the budget for the National Bureau of Standards has been flat.

At the March 3 hearing of the House Subcommittee on Science, Research, and Technology, several witnesses testified that the NBS budget should be doubled over a five year period—similar to what's been proposed in the President's budget for the National Science Foundation. For example, Dr. Robert Pry said that if we are serious about the competitiveness problem, that now is the time to assign additional projects to NBS and that NBS's budget should be doubled over five years.

(a) Do you agree with Dr. Pry?

Answer. Our Fiscal Year 1988 budget request to the Congress contains a 14% increase over our FY 1987 level. The initiatives in this budget request have been carefully planned and are ready to be effectively implemented. We clearly recognize the importance of the nation's competitiveness problem and are using the resources available to us in the most efficient manner. Planning for our future activities focuses on the competitiveness problem faced by U.S. industry.

Question. If you received a doubled budget over a five year period, how would you spend it? What programs would receive priority?

Answer. NBS can provide the most support to industry in the various emerging technology areas, i.e. research using the cold neutron facility, process control and quality assurance, advanced materials, electronics, automation and fiber optics. These areas are part of the requested increase in our Fiscal Year 1988 budget request.

Question. NBS had consistently more funding for specific programs in their request to OMB, but OMB has denied these increases. For example, for FY 1987 the NBS requested $10 million from OMB to do fiber optic research. I noticed that this year—after last year's denial of funding—you only requested $2.5 million from OMB for fiber optic research.

Does your FY 1988 budget request for fiber optics—and for other NBS programs such as advanced materials—represent what you think is necessary to run the best program, or is it based on your view of budget realities?

Answer. The $10 million requested to DOC in FY 1987 would have allowed NBS to provide comprehensive measurement support for the opto-electronic components required for fiber-optic communications systems. In FY 1987 NBS was appropriated $950,000 for fiber optic research. This level of funding has allowed NBS to develop selective measurement support for the three most critical components: sources, detectors and waveguides. The $2.5 million requested to DOC in FY 1988 would have enabled NBS to provide measurement services for additional components essential to lightwave systems, such as modulators, demodulators, amplifiers, switches, and couplers.

Our FY 1988 budget request is based on our view of budget realities. Fiber optic research can be done in logical stages. As additional funding becomes available, additional components will be addressed.

Question. In his statement, Pry also commented on the need for NBS to upgrade its regular laboratory facilities and scientific equipment. He said that NBS' research facilities must be upgraded if increases in private sector use of these facilities is to occur. Do you agree with Dr. Pry? Which facilities in your opinion, need upgrading? Is your Advanced Manufacturing Research Facility (AMRF) one of the facilities that need upgrading in order to facilitate use by private industry.

Answer. The AMRF was conceived and developed over the last five years with a very high level of support from both other agencies and the private sector. We continually review the need to upgrade and renovate our facilities and equipment. I believe the area to which Dr. Pry refers are those facilities (laboratory complexes) where the nature of the experimental and standards work must be continued, and the facilities made available to the private sector where appropriate. The use of specialized NBS facilities by the private sector for the purpose of conducting proprietary research has been approved as a policy for assisting U.S. industry to attain and maintain a high level of international competitiveness. Specific NBS laboratories have been designated as "national facilities" for this purpose. An example is the Cold Neutron Research Facility. The national facilities designation means that the particular facility is deemed to have certain characteristics that make investment by individual firms or even groups of firms infeasible. These characteristics include complexity and large size; and use by researchers across a diverse spectrum of technologies and thus firms and industries.

ADVANCED MATERIALS

Question. I am pleased to see that the Administration has requested a $1.5 million increase for research on composite materials. As you know, I am very interested in the area of advanced materials. Does the Administration's request allow for any new research in this area? Do you see room for an expanded effort—where would that be?

Answer. The requested increased of $1.5 million is to fund NBS research on polymer composite materials.

The NBS program is aimed primarily at providing measurement methods and other information that can be used to control and improve the processing of polymer composites. With this research, we expect to develop sensors which can measure chemical reactions, mixing, and flow under actual process conditions. Industry will be able to use these sensors and techniques to automate the productions processes to make them faster as well as to produce higher quality parts. The inability to process polymer composites rapidly and realiably is a major barrier to more widespread use of these advanced materials.

The NBS program will also investigate the factors which limit the useful lifetime of polymer composites. This research is expected to yield measurement methods and data that industry can use to predict more accurately the performance of polymer composites and to improve their durability.

Production monitoring techniques, durability and extension of the program to the performance of metal and ceramic composite materials will be addressed when additional resources are available.

QUESTIONS OF SENATOR PRESSLER AND THE ANSWERS

Question 1. Last year there was an agreement between this committee and the Administration relating to the cold neutron facility, the Center for Building Technology, and the Center for Fire Research. This agreement stipulated that this committee would authorize funding for the cold neutron facility at the National Bureau of Standards (NBS) and the Administration, in its 1988 budget, would not propose funding cuts for the Center for Building Technology and the Center for Fire Research. This committee fulfilled its part of the deal, although the Appropriations

Committee did not. Would you please comment on the Administration's FY 88 budget which cuts funding and combines the two centers?

Answer. The Administrations feels that the spirit of the agreement is being maintained. The centers are not being eliminated, ICST is being proposed for full funding, and the cold neutron source facility is being funded.

Question 2. Can NBS's fire research and building technology programs continue to be productive, if the centers are combined and funding reduced?

Answer. The fire research and building technology programs can be productive at a combined, reduced level. The new center would continue efforts directly addressing health and safety, such as work on earthquake hazards, structural safety engineering, studies on toxicity of combustion products and the computer modeling of smoke and fire spread.

Question 3. Is there any evidence that the private sector is willing to assume the fire and building programs or is NBS making the same arguments that it did last year?

Answer. There is no new evidence that the private sector is willing to assume these programs. Previous budgets recommended total elimination of these programs. Our position is that an effective fire research and building technology program can be maintained with the proposed reductions.

Question 4. Should NBS be doing more in introducing U.S. technology and standards in international markets?

Answer. NBS plays a pivotal and critical role in supporting the introduction of new technology by U.S. firms into international markets. International competitiveness is determined largely by three factors: cost, quality, and timing. NBS makes significant contributions to both the cost and quality attributes and times them through joint strategic planning with industry.

Equally important, NBS makes these contributions by leveraging every stage in the technology development and delivery process.

R&D and first commercial introduction

Scientific and engineering data and measurement methods are essential to the productivity of the R&D process. It is during development that quality is designed into the product. Moreover, the increasing ability to engineer materials to enhance desirable product attributes includes the ability to design for low-cost production as well as for quality. This trend further increases the demand for measurement-related infratechnologies provided by NBS. The increased complexity of new technologies requires correspondingly complex measurement methods and highly accurate data to support both R&D and process design.

Production

Increasing yield is one of the major objectives of new process technologies. Higher yields in production mean lower unit cost, but attaining this goal while maintaining the designed levels of quality requires real-time process control as opposed to the traditional end-of-the-line inspection. Real-time process control is a measurement-intensive process. NBS supplies important measurement-related elements of the emerging automation technologies.

Moreover, emerging automated production technologies are increasingly emphasizing flexibility in terms of product variation and systems-oriented control. Both attributes mean a greater need for sophisticated interface standards to ensure multiple vendors. Adoption of interface standards at the international level which are compatible with U.S. versions of the technology is essential for access by U.S. firms to world markets. Interface standards are just asd technically sophisticated as the other elements of a systems technology (such as communications or computed-integrated manufacturing). This is evidenced by the fact that NBS had to develop a state-of-the-art automated manufacturing research facility (AMRF) to develop the technical basis for needed interface standards.

NBS had to be able to design and construct the research facilities and acquire the skilled researchers well in advance of industry need.

Market development

Achieving "equity in trade" has always been an important role for measurment. In the past, this meant largely providing for an adequate system of weights and measures. Today, however, as more and more markets become technologically complex, market acceptance of new products requires technologically sophisticated acceptance testing, equipment and procedures. When test methods acceptable to both buyer and seller are not available, significant costs can be incurred as engineers and other technical staff of the two parties involved attempt to resolve the dispute. The higher *cost* adds to the effective price of the new product, so that not only is its

market development delayed by the disagreement but the increased price due to inefficient acceptance testing further slows market penetration. Such occurrences can be disastrous for U.S. firms participating in international markets where product life cycles are being increasingly shortened by intense competition. Being late in many of these markets can mean a permanent loss of market share.

Question 5. Should Congress appropriate funds for NBS programs, such as the National Voluntary Laboratory Accreditation Program, that seek to gain reciprocal acceptance of U.S. standards in other countries.

Answer. The National Voluntary Laboratory Accreditation Program (NVLAP) seeks to achieve acceptance by other countries of valid test data (such as from accredited laboratories) generated in the United States, thereby avoiding the time and dollar costs of burdensome retesting. The program was initiated with appropriated funds used to establish early Laboratory Accreditation Programs (LAPs). For the past three years, NVLAP has been successfully covering its cost through user fees. Additional appropriations are not warranted.

Senator RIEGLE. Dr. Merrifield, let us invite you to come to the witness table at this time. You are accompanied by Dr. Caponio, and we are delighted to have him here as well.

Dr. Merrifield, welcome. We are pleased to have you.

We are going to change the order of things a bit because we have a Finance Committee session going on this morning that both Senator Rockefeller and I are otherwise committed to be part of. Senator Rockefeller wants to raise some specific items with you while he is able to be here before going to the Finance Committee. So I am going to call on him now to do that, and let him pose some of the issues. We will ask you to submit your statement for the record so that we can turn directly to a discussion of these issues.

Senator Rockefeller.

Senator ROCKEFELLER. Thank you very much, Mr. Chairman. I appreciate that specific courtesy.

Dr. Merrifield, obviously I am very pleased that you are here. As an Assistant Secretary, you are important in any event, and you are particularly important to me because of the Japanese Technical Literature Act.

I care very much about that, only because I think, as I indicated earlier, it represents, symbolically, what we have to do in this country. It is the kind of things that we have to do in this country if we have any hope to keep up with or stay ahead of, in those few instances that remain, overseas competition.

The symbolism simply is that for 25 years or more, the Japanese have been reading everything that we have produced in our universities, in our government, that is, nonclassified material, and all of our industrial journals. They are trained in the English language. They learn the English language from the time they are in elementary school. This does not mean they all speak it perfectly, but their scientists and engineers are able to read it. In any event, it is translated.

In fact, in the Prime Minister's Office in Tokyo, there is an office which specifically relates to getting a hold of technological literature from overseas and making it available.

Now, we do not have the Japanese system. Theirs is a much more integrated system, in terms of business, government, and academia. Nevertheless, there are lessons to be learned from them. One of them is what they do in the technological field.

So that was the purpose of the Japanese Technical Literature Act, to spur us on. If they produce 10,000 journals a year and we

only read several hundred of them, we are the losers. We lose the technological information, they leap-frog us, and, in turn, we will then follow them, as we are now in too many fields.

I know that you are very concerned about implementing this bill, and I know that there are problems at OMB. I am very aware of that. You wear a relative white hat in my judgment, compared to OMB on these matters.

In any event, I do have some questions. The first of them has to do with funding.

The act calls for $1 million for Fiscal Year 1987, and the Commerce Department has committed only $300,000. The result of this, of course, is that if you are really at the business of translating all of these technical journals and doing what IBM, the University of Michigan, and others are not doing, we would be talking about a great deal of money. Realistically, I understand that we cannot do that. But we want to make an effort at it. It is an effort which we want to see grow stronger.

Associate Deputy Secretary of Commerce, Mark Policinski, stated last November that the Department had decided to commit the full amount of money, but now there is only $300,000 committed to this program. Why is that?

STATEMENT OF DR. D. BRUCE MERRIFIELD, ASSISTANT SECRETARY FOR PRODUCTIVITY, TECHNOLOGY AND INNOVATION, DEPARTMENT OF COMMERCE, ACCOMPANIED BY DR. JOSEPH F. CAPONIO, DIRECTOR, NATIONAL TECHNICAL INFORMATION SERVICE; AND JACK WILLIAMS, DIRECTOR, OFFICE OF PRODUCTIVITY, TECHNOLOGY AND INNOVATION

Dr. MERRIFIELD. First of all, I would like to point out that there are three different initiatives here that are related to this. What you are talking about is only one. The other two I will talk about a little later, if you like. One, of course, is machine translation of Japanese technology, which will take some development time. Another is the initiative that we are working on—four of us who are renegotiating the science and technology agreement with the Japanese which expires April 30. One of the initiatives that we propose is to make an addendum to the agreement which will be the translation, or at least the abstracting, of much of the Japanese literature. Only about 4 percent of their open source technology is currently translated into English.

As far as the current program goes, which you are talking about, I would like to ask Dr. Caponio, the Director of the National Technical Information Service, to answer that.

Dr. CAPONIO. Senator Rockefeller, although $300,000 has been reprogrammed for certain activities to carry on the implementation of the Japanese Technical Literature Act, I want to assure you that the Department of Commerce during calendar 1987 will expend over $2 million in carrying out the implementation of this act.

At the present time, there are five agencies within the Department of Commerce—namely the National Bureau of Standards, the Patent and Trademark Office, the National Telecommunications and Information Administration, the National Technical Information Service, and the International Trade Administration—all of

these agencies in the aggregate are expending over $2 million in terms of implementing the Japanese Technical Literature Act.

In addition, the National Technical Information Service is spending more than a quarter million dollars a year in terms of carrying out the act with the identification, the acquisition and the selective translation of certain technical report literature.

So I do feel that the department, as well as the administration, is fulfilling its obligation, and perhaps even more so.

Senator ROCKEFELLER. What is the priority of choosing what it is that will be translated?

Dr. CAPONIO. Senator Rockefeller, as you probably know, in the area of technological information there are two distinct contributing factors. One is the technical report literature, which usually emanates from sponsored research and development in the applied or engineering areas, in contradistinction to the results of basic or pure fundamental research, the results which usually appear in the scientific and scholarly journals.

The National Technical Information Service, over the last 40 years, has committed itself primarily to making available the results of both federally sponsored research and development as well as foreign research and development, that research and development sponsored by government agencies in the applied or in the engineering areas.

NTIS will continue to make available selected translations in the applied or the development areas.

Now, in the areas of basic scientific information, that which appears in the scholarly or scientific journal, as you have already mentioned, Senator, that is an overwhelming task. I think the only way we are ever going to be able to mount a complete translation effort is to apply the developments of computer aided translation.

As you yourself have indicated, there are over 10,000 scientific journals, most of which are not translated into English and also admittedly there are perhaps not more than 300 scientists and engineers in the United States who are capable of the bilingual facility. That is a problem that can only be overcome with a monumental effort in terms of the application of computer-assisted translation.

But, going back to what the Department of Commerce is doing, we are trying to catalyze the efforts of academia, industry, and other government agencies in providing whatever can be done at this particular time.

Senator ROCKEFELLER. With this joint effort that you talk about—I mean, sometimes in government, if the law says $1 million will be spent and then the question is how come only $300,000 is being spent, the answer comes back that we have four different groups working on this. That appears to answer the question. But it does not necessarily mean that it does.

In other words, the law calls for a certain amount and the amount is not being spent, regardless of what others are spending on it.

Let me just ask you this. Let's say there are approximately 10,000 journals. As a result of these four efforts that are being made, computer assisted and not, how many of those will be translated by virtue of the Federal Government, as opposed to private sector efforts, in this coming year?

Dr. CAPONIO. Senator, I cannot give you a precise number. As a matter of fact, I believe of the 10,000 journals, probably not more than a ballpark figure of 100 to 200 journals are being translated on a cover-to-cover basis.

Senator ROCKEFELLER. Do you mean by the Federal effort?

Dr. CAPONIO. Not even that many by the Federal effort. I am speaking in terms of the total number of Japanese journals that are being translated today in the United States by all enterprises. That would probably not be more than 200 scientific journals, on a cover to cover basis.

The Federal Government's contribution would be in the translation of selected articles from an X number of the so-called 10,000 scientific and technical journals.

Again, I do not have the precise number, but I will be happy to make it available for the record.

[The following information was subsequently received for the record:]

We do not now have data on how many Japanese language scientific and technical documents are being translated into English by U.S. Government agencies. However, the Japanese Technical Literature Act of 1986 requires that an annual listing of all such translations be published. NTIS is currently undertaking the survey work in preparation for producing the listing. The resulting data will be furnished to the Committee as soon as they are available. In the meantime, we estimate very roughly that about 4 percent of current articles are being translated by agencies of the Federal Government.

Senator ROCKEFELLER. But you will admit, won't you, that advanced ceramics, fiber optics, semiconductors, and all the rest, all the technology, the whole world of information that will define the 21st century and our position in it, if there are 10,000 journals being put out by the Japanese—and these are not incidental journals; they are for their people, by their people, with information, some of which is not available to us—if the answer is that we only translate by all efforts, public and private, approximately 200 out of 10,000, that represents idiocy, does it not? You would agree, wouldn't you?

Dr. CAPONIO. Yes, I would have to agree with that.

Senator ROCKEFELLER. You would have to agree with that.

Again, I come back to the $1 million. If it goes from 200 to 210, or 230, then that is 30 more pieces of information than otherwise would be contemplated.

I only say, Mr. Chairman, for the record that it is wild to me that we can allow this information to simply flow past us every year on the assumption, based upon our economic superiority in the 1950's, 1960's, and 1970's, that we still have all the information when we do not, and we all know it.

Now there is an act of Congress in which the Department of Commerce is directed to do certain things, one of which is to spend that amount of money. It is not doing so.

I do not blame you for that, but I want you all to know that I want to pursue this and work with you in a constructive manner on this.

Another matter, Mr. Chairman, is the so-called "Tokyo Office."

The act specifically calls for monitoring Japanese technical activities and developments, consulting with business people, and the

whole translation aspect of the Japanese Technical Literature Act. Jeff Bingaman and myself, Max Baucus and myself, Don Riegle and myself all at various times have pointed out the importance of having a presence ir Japan to monitor what they are doing.

In fact, in one of our bills, we go substantially farther than that. We pick out a number of different countries where they are doing leading edge research and development. We say that we ought to be represented some place in those embassies by people whose sole mission it is to be seeking out not only the journals but the people, and familiarizing ourselves with that.

Now, are we going to have an office in our embassy? Do we have an office in our embassy?

Can you catch me up on that?

Dr. CAPONIO. Yes, Senator Rockefeller. We are establishing an office in the U.S. Embassy in Tokyo and we will staff that particular Japanese Technical Information Office with a Japanese national who has been associated with NTIS over the past several years. Actually, he has been associated with the Mitsubishi Research Institute, one of the leading think tanks in Japan. He will be our key representative in the Japanese Technical Information Office.

So we are establishing that office within the U.S. Embassy.

Senator ROCKEFELLER. Dr. Kasuda is a retired National Bureau of Standards scientist who you have hired to assist in translations.

Could you tell me what he is doing?

Dr. CAPONIO. Dr. Kasuda was brought on board just recently to assist in the implementation of the act. He will be carrying on a number of assignments, one of which will deal with the translation of selective—again, I emphasize "selective"—technical reports. Another area will be an attempt to coordinate the monitoring of certain areas in science and technology. He will be also working with a number of other organizations with whom NTIS has entered into agreement in fulfillment of the Japanese Technical Literature Act.

I mention one, for example, George Mason University. We have a very active agreement with that university to begin to monitor some of the more important emerging technologies.

Senator ROCKEFELLER. I was with one of those gentlemen this morning.

I have one final question, Mr. Chairman, and I appreciate your indulgence.

Do you have a goal in terms of this act, either qualitatively or quantitatively, with respect to translation of the 10,000 journals, of which we are reading 200, and maybe 210? I mean, what is your goal, your public policy goal, under this Japanese Technical Literature Act?

Dr. MERRIFIELD. I would like to answer that.

Basically, our goal is to translate as much of these as we can.

We could not agree more with you that this is a vital concern to our country—to access continuing developments which are occurring everywhere in the world, particularly in Japan, where a lot of good things are happening.

It is our intent to try to accelerate this process as much as possible. What we are trying to do is run parallel tracks of effort.

One of our problems is that the Appropriations Committee did not appropriate any new funds for this process. This is all reprogrammed money.

One of my initiatives is to try to get private sector investments and involvement here, particularly to help with the development of the machine translation technology, which I think is the ultimate answer here, at least to abstract much of the technology. Then, selectively, we can fully translate those articles that are of particular significance, and even on a pay as you go basis, as industry expresses interest in those.

The other course of action is for us, under this Science and Technology Agreement, to try to insist that the Japanese begin to at least abstract their own technology literature in English at a progressive rate. This is going to be one of the conditions for renewal of the Science and Technology Agreement.

So we are going to run all these parallel tracks, and, hopefully, we will make good progress. I could not agree with you more. This is a vital concern and we need to make every effort that we can to do it.

Senator ROCKEFELLER. Mr. Chairman, I appreciate the constructive attitude of both Dr. Merrifield and Dr. Caponio, and I look forward to working with them on this bill and other related matters.

I thank the Chairman.

Senator RIEGLE. Dr. Merrifield, let me ask you this.

When we look at high technology items and try to gauge how we are doing as a nation vis-a-vis the rest of the world, there is a lot of distressing information. I mentioned earlier the fact that our high technology imports last year exceeded our exports. And we have had the report from the Defense Department study group to the effect that the Federal Government is going to have to come in and help the people in the semiconductor and super-computer areas, and so forth.

I would like your frankest assessment of where we stand today in the area of high technology vis-a-vis the rest of the world, and particularly the people of the nations which have focused on it, like Japan.

How are we doing?

Dr. MERRIFIELD. Let me talk about two categories. One is basic research. There is no question that we have an incomparable lead and capability that exceeds any other nation anywhere in the world. Basically, we are spending about $13 or $14 billion a year in basic research in this country, which is probably about 10 times more than anybody else does or can do.

No other nation has the academic infrastructure in place to do this sort of effort, to make this effort. A responsibility of the Federal Government is to fund this level of research. I would like to see this continuously increase and maybe double in the next decade because that is the seed corn that provides the new knowledge that is the basis for thousands and thousands of commercial applications.

However, our problem is in translating that early knowledge through the innovation pipeline. Normally, it takes maybe 7 to 10 years on average for a new discovery to be translated through the innovation pipeline into a useful product or process, and perhaps with 1 out of 10 or 20 ever producing a positive cash flow.

So it is a high risk—long term process.

Basically, we have also an incomparable industrial-technical infrastructure in this country to effect that translation. No one else in the world has the depth, the diversity, the breadth of technical capability that we do in our industry to make that translation.

However, we have major barriers to the process, one of which is the high cost of capital. It is about three times higher here than in Japan and other countries. Another major barrier is the antitrust laws, which have prevented collaborative efforts, first in collaborative R&D. As you know, we did get the National Cooperative Research Act of 1984 through, which has resulted in about 56 consortia, now, by the way, that have registered with the Justice Department.

If you would like a list of those, we can get it to you.

Senator RIEGLE. We would. Yes for our files.

Dr. MERRIFIELD. Sematech will be one of the latest ones, which is a landmark example of that.

We have to go beyond that now. Section 7 of the Clayton Act is a very destructive limitation on collaborative efforts in manufacturing, particularly flexible computer integrated manufacturing, which is necessary for the survival of U.S. manufacturing over the next decade. Currently, a barrier to collaborative efforts in manufacturing is presented by section 7. So it is important that we modify that law also to allow the procompetitive collaborative efforts in manufacturing that are necessary for survival of manufacturing.

There are about 100 regulatory barriers that need selective modification. The liability laws have been very destructive.

Senator RIEGLE. I appreciate the list that you are giving me here, and I would like you for the record to add whatever you want to it.

[The following information was subsequently received for the record:]

Some important barriers that need attention are: Product liability reform; section 7 of the Clayton Antitrust Act; inadequate process patent protection which allows foreign nation manufacturers to use U.S. technology and export finished products to the U.S.; Food and Drug Administration clearance procedures that take five to 10 years.

Senator RIEGLE. Let me ask you about the President's Commission on Competitiveness, headed by John Young, and the report they produced about 2 years ago.

How much of that has been implemented?

Dr. MERRIFIELD. About 90 percent of those recommendations have been approved by the Cabinet Councils as administration policy.

Senator RIEGLE. How about the Cabinet Department on Technology and the Cabinet Department on Trade? Have those been done?

Dr. MERRIFIELD. Dr. Merrifield misunderstood the question on the Department of Trade. Indeed, those were the ones that have actually picked up these as administration policy. However, not all of them hav[illegible]been implemented. Partly the problem is that we have had some of these barriers and a lack of incentive for this process of translation and innovation.

Senator RIEGLE. I am astonished to hear you say that, because I have talked with the members of the commission themselves. They

feel that the administration—I do not just say you—has been asleep at the switch on this; that very little of the commission's report has been implemented. The major things that have to do with structural changes, in order to really put a tighter focus on both trade and technology development have not been accepted, have not been adopted.

Is there a report today in existence, not one you would have to prepare, but one already in existence which shows the degree of implementation of the Presidential commission recommendations?

Dr. MERRIFIELD. Indeed there is. I can supply that to you.

Senator RIEGLE. Does it exist?

Dr. MERRIFIELD. It does.

Senator RIEGLE. Do you have a copy of it here today?

Dr. MERRIFIELD. I do not have one with me, but we can certainly supply it.

Senator RIEGLE. I would really like to see that because this is the first that I have heard there is such a report, and I certainly have not seen it.

Has it been circulated generally? Was it made public?

Dr. MERRIFIELD. It was provided to The Hill. About a year ago I believe was the latest version of that. Certainly we can make that available to you directly.

Senator RIEGLE. This is the first I have heard of it, and I have talked with my colleagues about it. I am not sure that even John Young, the chairman of the commission, is familiar with it. So it looks to me that if it exists, it is going to have to get a wider, maybe more aggressive distribution.

It seems to me that, if we are making all this progress, why did we have a trade deficit of $175 billion last year, or, roughly $170 billion? There are some differences on the exact number.

Dr. MERRIFIELD. Much of the innovation that is occurring in this country is small businesses. In fact, we created something like 700,000 small businesses last year alone here in the United States against maybe 50,000 perhaps that failed.

But many of these businesses do not know how to market overseas. I think the Commerce Department has identified maybe 20,000 or 30,000 commercializable, exportable products that are currently only marketed here in the United States.

One of our problems is opening up access to foreign markets for small and medium sized companies. About 80 percent of our international trade is carried on by only 1 percent of our companies.

One of the things we have been developing is our binational industrial R&D relationships with about 35 countries around the world now to provide joint venture opportunities for small and medium sized companies with foreign nations' companies to develop new technology and open that sort of access.

I think this is one mechanism for doing that.

Senator RIEGLE. Let me just ask you one other thing at this point.

When this Defense Department group issued its report on the problems of semiconductors and super-computers, it made what many of us thought was quite a revolutionary suggestion, namely, that the Federal Government ought to consider subsidizing a pri-

vate sector initiative in this area, or we are going to fall so far behind the Japanese that we will never catch up.

What is your impression of that set of findings and those recommendations?

Dr. MERRIFIELD. Well, there is no question that a targeting of industry, which has about seven steps involved, is a multiple form of hidden subsidies that the Japanese have discovered are very effective. They have put together these vertically integrated consortia, heavily subsidized, designed to price below cost with predatory pricing and to capture market share. As we all know, this has been very successful in consumer electronics and a lot of areas. And, in fact, no individual company in this country, not even perhaps IBM, can stand up to a whole nation that targets its industry.

Therefore, collaborative efforts are absolutely essential if we are going to be competitive in the hyper-competitive global economy against this type of strategy.

Of course, Sematech now, belatedly, is forming. We almost got that started 4 years ago, with Project Leapfrog, but it didn't quite get off the ground. Now it is, and I am convinced that we can recapture technical-industrial leadership in this area. But it is going to take that kind of colaborative effort.

I would like to see it primarily private sector funded managed and directed, rather than government managed and directed.

Senator RIEGLE. Is there enough private sector money in terms of the timeframe?

Why would this group at the Defense Department have suggested that the government is going to have to make some public investment in this?

Dr. MERRIFIELD. Well, there certainly is a national security issue here. We cannot exit this business and, therefore, a facility that will continuously generate next generation technology and maintain that technical-industrial leadership is absolutely essential.

Senator RIEGLE. Well, let's say that is right, and I tend to agree with that. But that sounds to me like it is a big step in the direction of targeting here, and it is, in a sense, industrial policy and picking winners and losers.

My colleague from Missouri and I have listened to an awful lot of debate over the years as to whether or not the Federal Government can or should cross this line into saying that there is some area where we are behind internationally and we need to add public resources. But to have gotten that recommendation now from a Defense Department study group I found to be quite a significant new aspect of this debate. As I hear you, you are being very careful in your choice of words, but it sounds to me as if you are saying that this is one area that we have to win.

Am I hearing you right? Are you saying that if it takes some public money in some form along the way to move us along, we had better just face up to that? Am I hearing you say that?

Dr. MERRIFIELD. Well, first of all, you are definitely hearing me say that we have to win this thing and maintain that technical leadership.

Number two, however, there are alternatives. The fiscal stimuli that are the tools of power that the government has are very limited and very clumsy—basically government loans, grants, and tax

incentives, of which the third is the only relatively noninterventionist one.

That is the one that I would prefer. I think the R&D limited partnership model is a marvelous example of that because it also is a new form of capital formation.

Senator RIEGLE. But are we not already late?

I hear what you are saying and I know it is nice to be able to do what is consistent with your philosophy. But it seems to me that at the same time you are saying that we are very late in this area, we are way behind the curve, we have a catch-up job to do, and the real question, is can the private sector, by itself, with a pat on the back from the government, get this job done in terms of taking on, in a sense, Japan, Inc?

I have some real doubts about that. I do not want us kidding ourselves because that fits our ideology. I want a very hard-nosed, practical answer, and I am not quite sure that I have head one yet.

Dr. MERRIFIELD. I don't think there is any question that we have the advanced technology that is unique in the world that can recapture this capability, this leadership in this industry. It is something that we have to do.

The private sector can do this.

Now, the only question is at what rate. The accelerated funding that is necessary is the question that needs to be decided.

I think, given the initial progress that we have in IBM's 4 megabyte chip, for example, we have a starting point that could get us into this situation pretty quickly. But it is going to take a concerted effort. We cannot waste a lot of time studying it. It has to happen. We have to mobilize the tremendous capabilities that we have.

We have them. They are not coordinated yet. Sematech, hopefully, will become that coordination function.

Senator RIEGLE. I would like to pursue this. But first, let me call on Senator Danforth.

Senator DANFORTH. Bruce, I am not sure you are the person to whom I should ask this question, but last year there was an agreement between this committee and the administration relating to the cold neutron facility, and relating also to the Center for Building Technology and the Center for Fire Research. The agreement with the committee was that we would authorize funding for the cold neutron facility at the National Bureau of Standards and the administration, in its 1988 budget, would not propose a cut for the Center for Building Technology and the Center for Fire Research.

We fulfilled our part of the deal, although the Appropriations Committee did not.

Is it your understanding that the administration is now welching on its part of the deal?

Dr. MERRIFIELD. Well, that is Ernie Ambler's area of responsibility. He was here a little earlier.

Again, that has been the OMB proposal, with which Commerce concurs.

Again, I think we have heard good testimony that these are very interesting and very important areas of research. The question is whether, if we do not fund these through Federal funds, they can be funded through collaborative efforts in the private sector.

That is a more difficult problem.

Senator DANFORTH. But the administration's position is not to follow through on what we thought its commitment was with this committee?

Dr. MERRIFIELD. I guess I am not qualified to comment on that one. You had better get Dr. Ambler to do that.

Senator DANFORTH. Okay.

As far as you are concerned, then, you have no doubts about the desirability of the programs?

Dr. MERRIFIELD. I think those programs are very important and merit very serious concern.

Senator DANFORTH. Thank you very much.

Senator RIEGLE. Let me come back to Sematech.

The Wall Street Journal article that was written on March 4, on this, one of the more recent articles, indicates that the consortium expects to come up with about half the money to run this show and they expect the Federal Government to come up with the other half.

Is that your sense for how we are going to pay for this?

Dr. MERRIFIELD. I think it is pretty speculative, still, as to whatever fundings arrangements that will be worked out have really been worked out. It is going to take a while to work those out.

My preference would be that it be funded in the private sector by the private sector, as much as possible.

I think that is everybody's preference. But you are really sort of side-stepping the issue. Maybe you feel that you have to do that.

The question is, if the industry cannot cough up enough money, are you, is the Secretary, is the President, is the administration willing to stand up and say—I mean, you have said everything else, that it is a critical area, we cannot lose, we have to close the gap, et cetera—that we are prepared to commit the resources to do it? If not, then everything else you have said does not mean very much, does it?

Dr. MERRIFIELD. Well, the point, again, coming back to is, is that this is a vital concern. Whoever owns mass memory in semiconductors owns super-computing, telecommunications, flexible manufacturing, and a thousand other applications. Therefore we cannot exit that area, this industry.

So it is important that we find a way to do this and whatever it takes to do that I think is going to be necessary.

What I would like to see is the maximum effort be made by the private sector first to find the funding by itself, and if it cannot do that, then in nondirect ways, perhaps with special tax incentives or perhaps government guaranteed loans that will allow them to borrow the money from banks and so forth to cover their costs.

But I would like to see it as much as possible done in the private sector. I think the market focus is a critical factor here.

Senator RIEGLE. Well, it sounds to me, when you talk about tax policy, you talk about guaranteeing loans. It sounds to me that what you are saying is we want it to happen and we want it done in the private sector. But if it comes to the point where the government has to put any direct money in, we draw the line there and we are not going to do it.

Dr. MERRIFIELD. Well, I do not think that anybody can make that statement yet. We will have to see.

I think it is still in the process of being costed out; in fact, all the specific objectives of the program have not yet been fully worked out.

Senator RIEGLE. How urgent is this problem, in your view?

Dr. MERRIFIELD. I think it is first-rate. It is a very important problem.

Senator RIEGLE. As important as any problem of this kind that you see in the government right now?

Dr. MERRIFIELD. Absolutely.

Senator RIEGLE. Are there any other areas, sectors of our economy, where you see an equivalent threat and a sense of urgency?

Dr. MERRIFIELD. Well, basically, the three things that are probably ten times more important than anything else are innovation, automation, and reskilling: innovation to generate next generation technology continuously, to recapture and maintain leadership in almost any industrial area; flexible computer aided manufacturing, without which manufacturing will not survive in this country; and lifelong, continuing reskilling of the workforce, which is absolutely essential.

Senator RIEGLE. I think we all agree with that. But I am really posing a different question.

I am saying now that the administration has identified a specific industry area in terms of these semiconductor problems, where there is the need for a unique sort of national effort.

Are there any other major technology areas or product areas where you see an equivalent requirement now, or does this one stand out by itself?

Dr. MERRIFIELD. I think this one stands out pretty much by itself.

I think it is the only one that I have identified that has a national security issue as well as an industrial survival issue associated with it.

Senator RIEGLE. Let me give you another one to think about.

What about producing engines? I know this is a little more pedestrian than super-computers or semiconductor chips. But we have a situation developing in the manufacturing base. I could give you one example, the Wohlert Company out in Michigan. It is the premier company making flywheels and engine rings. It is probably one of the most efficient companies of its kind in the country. They produce over half of the engine rings and flywheels for the roughly 40,000 engines that we build in this country every day of all sizes, shapes, and so forth.

They think they are about to be driven out of business by Korean competition. They have managed to adjust to Japanese competition. But the cost levels are so much lower in what looks like a targeted thrust by the Koreans that they are not sure they can survive.

I do not know how we can build engines here if the premier company for the internal engine parts is not on shore. Are you looking at that?

Dr. MERRIFIELD. That is a good point. What it says, again, is that any existing industry can be targeted from abroad with low-cost

labor and other resources, and captured, with subsidized government help.

In fact, that is indeed what is happening in Korea. I was just there. They tell me that they are currently underpricing Japan by 30 percent now. You cannot believe the investments that they are making in advanced state of the art technology with $2 an hour labor versus $12 an hour in Japan.

So there is no question that the existing industries—and there are about 100 of them—that are currently being targeted will be selectively captured by the developing countries, which is a new event in industrial history now.

As a result, the answer to this has to be to generate the next generation technology. Maybe this will be the advanced ceramic engine, or maybe it is an electric vehicle with a high energy density battery.

But these are the kinds of things that are going to have to happen if we are going to be participating in those industries.

Senator RIEGLE. Let me just ask you one other thing along that line and then, if Senator Danforth has some additional questions, we can get into those. Then we must get to our next panel.

Why aren't engines of all sizes and shapes in a sense in the same kind of strategic category as semiconductor chips? In other words, how does a nation like ours really function if we do not have state of the art engine manufacturing capacity on-shore in the United States? Why isn't that a national security issue as much as computer chips?

Dr. MERRIFIELD. Well, I think primarily because it is not going to shut down our industry, really. It is only one component of a lot of components that go into an automobile.

Senator RIEGLE. I am not just thinking about automobiles. I am talking about all engines. I am talking about engines of every size and shape that run all kinds of things, including military vehicles.

I mean, if suddenly we did not have any replacement engines, you don't think that would be a problem for us?

Dr. MERRIFIELD. Well, I think we can recapture this industry with flexible manufacturing systems—but, again, our basic thrust, and we have to focus on this, is next generation technology, which we have advanced knowledge for, which nobody in else in the world can generate.

That really has to be where our primary focus is.

Senator RIEGLE. I have a whole host of other questions, many of them very technical questions, which relate to the work of NTIS, and particularly to your suggestions that we privatize some of the operations. In other words I have a number of detailed questions that I want to ask in that area.

I am also going to ask you for the record to give us a list of the other areas that have been identified as strategic and, where the Japanese have targeted research consortia to accomplish certain objectives. I think we also need a very discrete list of what we have in that area. Also, we have some questions having to do with the Federal Technology Transfer Act, and we will give you those for the record and ask you to respond in some detail to those.

Senator Danforth.

Senator DANFORTH. No more questions. Thank you.

Senator RIEGLE. We thank you.
[The statements follow:]

STATEMENT OF DR. D. BRUCE MERRIFIELD, ASSISTANT SECRETARY OF COMMERCE

Mr. Chairman: I am accompanied to day by Dr. Joe Caponio, Director of the National Technical Information Service, who has submitted a statement for the record, and who will answer questions pertaining to NTIS, including the privatization proposal and the implementation of the Japanese Technical Literature Act.

We are proposing that the authorization for the Office of Productivity, Technology, and Innovation, or OPTI, be $1,900,000 in fiscal year 1988. The money is to be used for a phase-down of OPTI. A core staff of 10 people, funded at the level of $675,000, will remain after the phase-down to advise the Secretary on technology and innovation issues.

We believe that phase-down is appropriate now since OPTI has successfully completed many of its major tasks, including:

By the passage of the National Cooperative Research Act of 1984, a major antitrust barrier to cooperation in R&D among U.S. companies has been removed; already 54 consortia have notified the Federal Trade Commission and the Department of Justice pursuant to this new law.

OPTI's Industrial Technology Partnerships Program has helped to stimulate over $3 billion of private sector R&D financing through the use of research and development limited partnerships (RDLPs) in the last several years. Prior to this time, the RDLP mechanism was not a significant contributer to innovation. State governments are now taking more and more initiative in innovative financing mechnisms. We believe OPTI has been influential in this process.

OPTI's Federal Technology Policy program played an active role in the issuance of a 1983 Presidential Memorandum that makes contractor ownership of inventions government-wide policy. Provisions were included in P.L. 98–620, which extends the principle of contractor ownership to some of the largest government-owned, contractor-operated laboratories.

Finally, recently enacted P.L. 99–502 increases private sector collaboration with our federally owned and operated laboratories.

The smaller OPTI staff remaining after the phase down will continue to function as the Department's focal point and advocate on policy matters involving productivity, technology and innovation; and to assist the private sector to form cooperative R&D ventures, especially in leapfrog technologies where the R&D efforts cut across traditional industry lines and where Federal laboratories can contribute expertise.

This request for a reduced program effort represents a compromise from recent Administration requests to terminate OPTI and I seek your support.

I would also like to describe to you today the steps that are presently underway by the Administration to implement the Federal Technology Transfer Act of 1986. President Reagan in his February 17 speech on competitiveness stated "we will recruit science entrepreneurs to act as conduits between the laboratories and business, venture capitalists and universities. We will also encourage exchanges between federal laboratories and private industry, so each can benefit from the other". To carry this out, the President has announced his intention to issue an Executive Order on this subject. The Department of Commerce is playing an active role in implementing the Act, including the preparation of model agreements for cooperative research between federal laboratories and private companies.

Regarding the National Technical Information Service, consistent with the Administration's privatization initiative, in FY 1988 the private sector will be offered the opportunity to operate the entire NTIS under contract, with the Government retaining overall policy direction. Several privatization options, some of which involve employee stock ownership, are now under consideration. We also plan to seek the views of the private sector to determine how much interest there is in administering the NTIS function. Before we decide the approach to take, there are a number of issues to be considered, including:

Continued availability of Government agencies' materials;
Disposition of deposit accounts;
The assurance of minimum adverse effects on NTIS employees;
What effect copyright protection has on the attractiveness of privatization;
The impact, if any, on current international agreements; and
The mechanism for contract oversight.

The Administration recognizes these as issues that require attention, and a staff working group is looking at them.

In conclusion, Mr. Chairman, I would like to emphasize that technological innovation and productivity enhancement remain as critical as ever to our economic growth, the development of new jobs, and the competitiveness of our industry internationally. To regain and maintain world economic leadership, the United States must capitalize effectively on its natural advantages, especially its great breadth and depth of scientific research and its unparalled entrepreneurial culture. To do this, Administration policy will continue to be directed at promoting cooperative efforts, and removing barriers to increased productivity and innovation.

Thank you, Mr. Chairman. I will be happy to answer any questions.

Statement of Dr. Joseph F. Caponio, Director, National Technical Information Service, Department of Commerce

Mr. Chairman and Members of the Subcommittee: I am pleased to appear before you today to request authorization for the programs of the National Technical Information Service (NTIS) for Fiscal Year 1988.

We are not requesting appropriated funds in Fiscal Year 1988, but I would like to review some of our recent accomplishments.

NTIS provides products and services designed to increase the flow of technology and strenthen the U.S. competitive position in the world marketplace. The NTIS enabling legisiation (15 U.S.C. 1151-1157), passed in 1950, directed the Secretary of Commerce to establish and maintain this clearinghouse. All operating costs are funded from the sale of the products and services to business, industry, Government, and other interested individuals and organizations.

In Fiscal Year 1986, NTIS acquired and made available 70 thousand new domestic and foreign Government-sponsored research, development, and engineering reports, bringing our total collection to approximately 1.7 million titles. NTIS sold 452 thousand copies of documents in paper and 1.9 million in microfiche. Several automated systems became fully operational, such as the on-line ordering and subscription systems, and on-line access for deposit account users. These are being expanded to include other features to improve service to customers.

JAPANESE TECHNICAL INFORMATION

NTIS is continually interested in the acquisition of foreign scientific and technical reports, and we are particularly committed to expanding the acquisition, translation, and dissemination of Japanese information, spending approximately a quarter of a million dollars on this work in Fiscal Year 1987.

A number of Department of Commerce agencies are working in close cooperation to implement provisions of the Japanese Technical Literature Act of 1986. The United Secretary for Economic Affairs is establishing a functional unit within his office to oversee implementation of the provisions of the Act. NTIS has engaged the services of an expert on Japanese information to manage its activities related to the Act. Provisions of the Act are now being implemented including: continuation of acquisitions, and translations to a limited extent; compilation of a directory of U.S. programs and services which provide access to Japanese technical literature; compilation of a listing of English translations of Japanese technical documents available to the public from U.S. Government sources; work on several cooperative projects with trade and industry groups to determine needs of industry for Japanese technical information; and, establishment of an office in Japan staffed by the NTIS Japanese acquisition representative. Implementation of other requirements in the Act will begin within the next two months, either by NTIS or other Department of Commerce agencies.

PATENT LICENSING PROGRAM

In Fiscal Year 1986, the NTIS Patent Licensing Program granted 51 new licenses; filed 166 foreign applications on 16 U.S. inventions; paid incentive awards to 147 Government employee inventors; and returned royalties of approximately $4.2 million to the U.S. Treasury. Unlike past years, no appropriations will be required for this program in the Fiscal Year 1988. The program will be financed by the retention of licensing fees paid by licensees and by reimbursable agreements with agencies for whom NTIS provides license management services. In accordance with the Federal Technology Transfer Act of 1986, receipts in excess of authorized program costs will be returned to the Federal agency originating the invention.

PRIVATIZATION

Consistent with the Administration's privatization initiative, in FY 1988 the private sector will be offered the opportunity to operate the entire NTIS under contract, with the Government retaining overall policy direction. We are currently looking at several privatization options. One is going to the private sector to see how much interest there is in administering the NTIS function. Other options could involve employee stock ownership of the firm taking over the function. In other words, employees would be given stock in the firm operating NTIS. The shares would entitle them to some control over the business and a stake in its success. Depending on the alternatives selected, the business could be both owned as well as operated by the employees. Before we decide which approach to take, there are a number of issues that have an impact on the approach including:

Continued availability of Government agencies' materials
Disposition of deposit accounts
The assurance of minimum adverse effects on NTIS employees
What effect copyright protection has on the attractiveness of privatization
The impact, if any, on current international agreements
Mechanism for contract oversight

The Administration recognizes these as issues that require attention, and a staff working group is looking at them.

Let me assure the Committee that, as Director of NTIS, I am concerned with the effects any change in NTIS will have on its employees. To this end any contract offer will be reviewed to ensure that it offers the minimum adverse effects on NTIS employees. I am committed to ensuring their rights are protected and that their views are considered. We will keep the Committee informed of our progress.

This concludes my statement, Mr. Chairman.

[The following information was subsequently received for the record:]

QUESTIONS OF SENATOR RIEGLE AND THE ANSWERS

(1) FOREIGN TARGETING OF U.S. INDUSTRIES

Question. To the best of your knowledge, how many American industries and technologies have the Japanese now "targeted"—that is, launched efforts to become world leaders? For example, an April 1986 report from the National Science Foundation's Tokyo office (Report Memorandum #98) lists 25 areas where the Japanese government plans to form new research consortia, many in areas of American strength. How many others are there?

Answer:

Industry Targeting:

We do not maintain a list of targeted U.S. industries. Since the U.S. represents the world's largest market we have to assume that nearly all of our industries are targeted by one country or another. Industrial targeting is coordinated government actions that direct productive resources to give domestic producers in selected industries a competitive advantage. There are four elements to this definition.

1. There are coordinated government actions.
2. Productive resources are directed by the governments.
3. Selected industries are targeted.
4. The purpose is to provide domestic producers in these industries with a competitive advantage.

Targeting techniques include the selective use of home-market protection, tax policies, antitrust exemptions, science and technology assistance and financial assistance. Overall effectiveness of targeting is very difficult to quantify and assess. The U.S. International Trade Commission has reported on the effect of industrial targeting actions of Japan and of the European Community and its members on U.S. industries.

Technological Targeting:

The NSF *Report Memorandum #98* reported on the 25 proposals funded in the first year of the Japanese Key Technology Center (JKTC) program of long-term R&D projects. In the JKTC capital investment program, two or more companies must jointly establish an R&D company or consortium. The JKTC may provide up to 70 percent of the capital required for the R&D project. The next set of consortia selected by the JKTC for funding will be announced soon, we understand.

In addition to the JKTC program, Japan has, to our knowledge, at least 19 different programs to encourage technological innovation. Some of the technologies and dollar amounts are listed below:

Chemical Technology: $61 million.
Manganese Nodule Mining System: $36 million.
Scientific Computing System: $35 million.
Advanced Robot Technology: $32 million.
Automated Sewing System: $24 million.
Resource Remote Sensing System: $40 million.
Water Reuse Systems: $6 million.
Interoperable Database System: $5.3 million.
Advanced Technology Processing System: $94 million.

An example of the ability of the Japanese to respond to new technological opportunity is in superconductivity. About a week after the February 15, 1987 announcement of the major scientific breakthrough in superconductivity, the Japanese consortium was in place. The initial members include Nippon Electric Corporation, Toshiba Corporation, Nippon Steel Corporation, and Mitsubishi Electric Corporation. Their objective is to organize industry to get the jump on the West in applications and commercialization for this huge new market.

In summary, Japan, other industrialized, and newly industrializing countries are organizing their resources for strategic advantage. Cooperation among university, industry and government is occurring at every technological leverage point and appears to be constantly increasing.

(2) FEDERAL TECHNOLOGY TRANSFER ACT

Question. Last year your office helped this Committee draft the Federal Technology Transfer Act, a statute that allows civil-service run federal laboratories to enter into cooperative research projects with industry, State agencies, and universities. That law is new, but what has the reaction been so far from both Federal agencies and from companies and state officials? What assistance will the Department of Commerce provide to agencies, companies, and states to help facilitate cooperative research?

Answer. The Department is working closely with other agencies to expedite implementation of the Act as a major component of the Administration's competitiveness agenda. There is a great deal of interest in the new law in the agencies, their laboratories, the private sector, and State and local governments.

The Department was closely consulted in the drafting of the April 10, 1987, Executive Order facilitating access to science and technology. The new Executive Order directs that agencies shall "delegate authority to its Government-owned, Government-operated Federal laboratories:

(A) to enter into cooperative research and development agreements with other Federal laboratories, State and local Governments, universities, and the private sector; and

(B) to license, assign, and or waive rights to intellectual property developed by the laboratory either under such cooperative research or development agreements from within individual laboratories."

This directive will help speed implementation of the Act.

The Department of Commerce is preparing a number of tools which will greatly assist the agencies in using the authorities of the Federal Technology Transfer Act. For example, the Department will soon complete a training course for Federal employees to develop the skills necessary for successful technology transfers to the private sector. The course is based on the successes of our universities and will also be available for others, such as State and local government officials, who are working to integrate public research facilities into the local economy.

The Department will also develop model patent licensing agreements for the laboratories as another important teaching tool. This type of resource is very important to laboratory directors who are interested in forming cooperative R&D agreements with industry.

There has been a great deal of interest in the Act as a crucial part in a successful strategy to increase economic development in the U.S., and to maintain our international competitiveness. The Department has mailed a number of information packets to private industry, State and local government officials, and Congressional offices who are interested in contacting Federal laboratories.

The Department hosted a meeting on March 27, 1987 for the senior Washington representatives of the States. The meeting covered different Departmental programs and resources which could assist economic development in the States, and featured

a panel on the Federal Technology Transfer Act. The Department has assisted many States in identifying the Federal laboratories in their areas which can now work with local government in fostering economic development through the authorities of the new law.

The Department is vigorously working with its own laboratories in implementing the new law and has been delighted with the interest shown from the private sector in performing cooperative R&D under the new law.

(3) NTIS PRIVATIZATION

Question. OMB has now directed that the National Technical Information Service (NTIS), a self-supporting publications agency under your direction, be "privatized." It appears that OMB either wants a private company to take over NTIS on a contract basis or else turn it into a employee-run company. I have several questions about this proposal.

Question (a). Except for a small patent licensing unit which receives appropriations, all of NTIS—and particularly its publications operations—is already self-supporting. It sells reports on a cost-reimbursable basis. What, then, is the rationale for "privatizing" this agency? How can the Government save any money when it already spends none?

Answer. Raising revenue was not one of principal rationales for the decision to privatize NTIS. The overall goal was a more fundamental one of ensuring that the Federal Government does not retain within the government activities that are better suited to private operation. Nonetheless, the government may find financial advantage from several aspects of an NTIS privatization. A private firm may be willing to pay a substantial amount to have the "exclusive" right to operate NTIS. Also there will likely be savings on pension costs and other items.

Question (b). Normally when we consider contracting out a Federal activity, the Department conducts a so-called A-76 reviews to analyze costs and benefits. Why have OMB and the Department decided not to conduct an A-76 review in this case? And isn't it a fact that earlier A-76 reviews of parts of NTIS showed that the Government could provide the service more cheaply than private companies?

Answer. It is true that earlier A-76 studies for parts of NTIS have been "won" by the government. No A-76 study of the entire NTIS operation, however, has ever been conducted.

Question (c). Since private companies, unlike NTIS, must make a profit, won't privatization in fact lead to higher publication costs for the customer? And what is to prevent a private company from dropping important but not immediate profitable product lines?

Answer. Whether privatized or not, the answer is the same. NTIS operates in a business environment. NTIS is constantly introducing, upgrading, and scaling back its product line. It has some new products which are successful immediately, some which need a long incubation period, and some which fail. It faces the same business decisions as any business when attempting to identifying demand and can never be totally certain that the time has come to discontinue a product. This decision is as difficult for NTIS as it would be for a successor. In short, this is a process which will go on regardless of the form NTIS takes.

Question (d). NTIS receives, and then sells, documents voluntarily submitted by such Federal agencies as the Defense Department, the Energy Department, and NASA. Would they turn over their documents to a private company?

Answer. Under options present being considered, a core group of NTIS employees would remain to act as the focal point for the collection of reports. This should ensure the continuation of submissions by all agencies which presently use NTIS.

Question (e). As you know, this Committee feels strongly about the new Japanese technology literature program. That program's success depends on the ability of NTIS to negotiate new Government-to-Government information access agreements with Japanese agencies. How can a private company negotiate with the Japanese Government? Will it even be willing to try?

Answer. Although NTIS plays an important role in the implementation of the Japanese Technical Literature Act, it is the responsibility of the Under Secretary for Economic Affairs to coordinate the Department's implementation of the Act. Government-to-government agreements may be implemented through that office.

QUESTIONS OF SENATOR DANFORTH AND THE ANSWERS

Question 1. By drastically reducing the staff at the Office of Productivity, Technology, and Innovation, are you eliminating a focal point and an advocate within the Administration for productivity and technology transfer programs?

Answer. This reduction would substantially diminish, but not eliminate, OPTI's ability to play these roles.

Question 2. Would the Administration's plans to allow the joint ownership of manufacturing facilities inhibit the formation of new, small firms, interested in manufacturing?

Answer. No, the concept of joint ownership of manufacturing facilities would spur the formation, continued existence, and rapid expansion of new small firms involved in manufacturing.

It is necessary for small firms developing and delivering new products to be globally competitive in price, quality, time of delivery, and rapid responsiveness to customer needs. Those competitive factors can be achieved through flexible manufacturing systems that may be beyond the managerial, technical, and/or financial capability of many small firms. Joint or third party ownership of an FMS facility would provide the production capability for competitiveness in global markets—different products could be produced in virtually any quantity at the same low unit cost, with world class quality, and just-in-time delivery. Only through such an approach can the U.S. maintain and expand its base of small and medium size manufacturers, critically needed for both the civilian and defense economies. Another benefit would be the restoration of U.S. industry's reputation for quality, which—it has been argued—has been lost to our overseas competitors.

Question 3. Why are our firms experiencing difficulty in using the newest technology in their products when the U.S. possibly has more scientists and more technical resources than most other countries in the world?

Answer. Secretary Baldrige testified recently: "Most of our firms do not take advantage of our unparalleled technology base. In some cases, our competitors make better use of it than we do. The ceramic engine, which we invented, but which the Japanese will soon commercialize, is a good example. Our firms need to take more initiative. Our firms need to use our technology and science base to accomplish breakthrough developments that 'leapfrog' existing state-of-the-art products."

The ability to translate new technology into new products and processes is less dependent on technical talent and technical resources than on the investment strategy of firms. Technology only makes new marketable products and processes possible. Invention is the first, and least expensive step, in the long (9 to 10 years often) and expensive process of innovation. Unless a U.S. firm makes the additional investment—in late stage R&D to translate that invention into a product, in up-to-date production facilities and engineering to produce the product, and in marketing strategies and sufficient resources to take it to the market—that invention will make no contribution to our competitiveness.

Part of the problem is lethargy. Because the life-cycle of products is collapsing, a company can no longer assume that it can make the same product for many years. Yet, too many of our firms resist developing new products even though they know their existing product line is no longer truly competitive. Instead, those firms avoid market risk and spend their R&D dollars on marginal improvements to existing products. This represents a failure of market strategy. Likewise, many of our firms have been unwilling to incur the cost and organizational trauma associated with newer, more efficient production technology and techniques.

The major barrier, however, is the total cost of bringing a new product to the market. It is true that late stage R&D—the stage during which an invention is translated into a new product—is expensive. But the problem is not simply insufficient R&D funding. The cause of the "constipation" of our innovation system lies less with the level of the R&D effort than with the firm's existing manufacturing facilities. A firm normally will fund the high cost, late stage R&D for a new product only if it intends to manufacture that product. Most of our production lines are "dedicated." That is, they are designed to make only one product. Shifting to manufacture a new product is difficult and expensive. Therefore, a new product R&D funding decision involves not only the R&D costs. Often it requires scrapping the existing production facility and building a new one. A new product R&D decision is, thus, essentially a capital investment decision.

The underinvestment, or rather the sometimes misdirected investment, of R&D funds is, therefore, partially the result of our outmoded production infrastructure. The existing dedicated plants which many of our firms cling to are, in effect, a bar-

rier to commercialize new products. By contrast, our competitors have been more willing to upgrade their production facilities.

Nor is it simply a matter of investing in automation. Even an automated facility, if inflexible will live or die with the product it is designed to produce. As product life-cycles become shorter it becomes prohibitively expensive to build new dedicated production facilities for every new product or variation thereof, especially an automated facility.

The key element is flexibility. If our firms have flexible computer integrated manufacturing (FCIM) facilities that are capable of making a wide range of products, then a new product R&D funding decision would not be burdened by heavy capital investment costs. The largest single investment cost related to bringing a new product to the market woud be removed. FCIM would unbundle the R&D and the capital equipment decisions and make it much easier for firms to spend their R&D budgets on new products, and subsequently to manufacture and market them.

And, FCIM allows firms to increase dramatically their responsiveness to market demand. It is the most effective way for our firms to move new products into production quickly, and to increase the quality of products and the efficiency of production facilities, and rapid market penetration.

FCIM production facilities can be created by individual firms or by groups of firms which share the investment costs. Or FCIM facilities could be created and operated by entities that do nothing, but manufacture for other companies, much like time-sharing of computers. FCIM facilities could be "job shops". If operated as an "open access" facility, new as well as existing firms with innovative products could commercialize them rapidly and actually enter the market with no capital investment costs. In addition to increasing the competitiveness of our existing firms, this would allow new companies, one of America's greatest weapons, to be used to maximum effect, especially if such firms were allied with existing marketing firms. In addition, an in-place FCIM production base would satisfy the mobilization requirements of the Department of Defense at little cost.

As Secretary Baldrige recently testified: "Probably the most important single need is investment in flexible computer integrated manufacturing facilities (FCIM). Our firms need these to replace their existing inflexible, dedicated facilities that make it difficult and costly for our firms to bring new products to production. Those old manufacturing facilities have increasingly become an albatross around the neck of our industry. FCIM has truly incredible potential for U.S. firms to regain world leadership."

No matter how brilliant our science is, our firms must have the aggressiveness to attack new market opportunities with new products and commit the necessary follow-on resources in R&D to turn our inventions into new products, in the production technology, and in the capacity to bring these new products to the market quickly. The investment in FCIM production facilities may be the most critical single step in increasing our competitiveness.

Question 4. If the National Technical Information Service is not privatized, how could it increase the use of its services?

Answer. As noted earlier, NTIS operates in a business environment, continually seeking to provide the products and services that meet the needs of NTIS customers and source agencies. If it is not privatized, NTIS would continue in this same manner.

Senator RIEGLE. We are now going to move on to our next panel, consisting of Dr. Cannon, Mr. Nemeroff, and Mr. Bay.

Gentlemen, welcome. We are delighted to have you this morning.

Dr. Cannon, let us have you go first.

We will put your entire statements in the record. I think it would be helpful to us if you just summarized as directly as you can, and feel free to be as blunt as you want to be here today. If you want to make any references to earlier things that have been mentioned, please do so.

Dr. Cannon.

STATEMENT OF DR. PETER CANNON, VICE PRESIDENT-RESEARCH AND CHIEF SCIENTIST, ROCKWELL INTERNATIONAL

Dr. CANNON. Thank you, Chairman Riegle, and good morning, members of the subcommittee.

My name is Peter Cannon. I am Vice President of Research and Chief Scientist at Rockwell International Corporation. I would like very much to thank you and Senator Hollings for providing me with the opportunity to present views on the subject of competitiveness and the National Bureau of Standards.

I wish to emphasize that I speak for myself, as a scientist and manager of scientific research, and as a business person with over 30 years of experience.

I have spent a substantial part of the last 6 years chairing assessment panels for the National Bureau of Standards.

The challenges of competitiveness are those in which we measure our ability to produce jobs, raise our standard of living, and resolutely to defend ourselves. The indicators of present competitive pressure are well-known. They include things like decelerating GNP growth, mounting trade deficits, low investment, declining productivity, and, perhaps most important of all, shameful educational statistics.

The causes of such indicators partly come from external sources, which are beyond the control of individual private citizens or firms. But internal sources for these difficulties are within our own ability and responsibility to control totally.

Among the most prominent causes are the following: a new global competition in science and technology; the failure of some management to put the long-term first, particularly the long-term investment in skilled people and an educated marketplace; trade policies that just are not aggressive enough and that do not have a global perspective, or even a contemporary view; volatility of the dollar and an uncertain micro-economic environment which makes for a lack of resolution on the part of my business colleagues; and, finally, a marked deterioration in our educational system, a situation so bad that the National Commission on Excellence concluded, and I quote: "If any unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war."

Four years have passed since the issuance of that report. Some positive steps have been taken. A great deal remains to be done.

There are many causes but no one answer.

Accordingly, short-term solutions which only protect disabilities should be avoided. A foot race between two can be won by hamstringing the opponent; but it does not do the winner any good.

We must improve our ability to compete.

There is one factor which we can manage to a timely position of competitive preeminence, that is, technology, scientific and technologic innovation, America's long suit, to be formed, added to, and played well.

It is estimated that technological innovation accounts for 44 percent of U.S. productivity increases since World War II, and that each high tech job creates at least five, and perhaps ten, jobs in the service sector.

Technology provides us with leadership. Because of the value that it adds to products, Americans today have higher wages than other nations, and, rather than envy others low labor costs, we should be proud of our higher standard of living.

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Technology is a force multiplier. We have been able to defend ourselves without matching potential adversaries man for man, tank for tank, plane for plane. Technology makes our lives safer, cleaner, healthier.

Our dependence upon technology is acute and growing.

The competitive quality of our products and the productivity of our labor are intimately linked to the timely use of technical strengths.

The conclusion is quite clear: If we are to grow economically, then American industry must continuously be on the leading edge of technologic change.

How do we accomplish this?

Very vigorously and with very deliberate plans.

Science and technology—S&T for short—cannot be taken for granted. They must be nurtured. The environment in which they exist must be conducive to research, to study, to risk, to effort.

At the base must lie an educated citizenry.

Trendy beliefs to the contrary, technical innovation, which keeps American industry globally competitive, is not done in private garages. Instead, it results from very large-scale, painstaking efforts of very large numbers of well educated people, working in rather expensive surroundings. The provision of a technology-friendly environment, to coin a term, has been a major contribution of government worldwide since World War II.

The greatest successes in the U.S. and elsewhere flow from facilitation and incentivization, and we do need government's participation and cooperation in setting the environment.

A more conducive and contemporary environment might follow from some well chosen reforms. Some, we have heard, are needed in regard to the anti-trust law, particularly the Clayton Act, to extend the liberal interpretation of it with regard to cooperative research, to cooperative manufacturing. This could certainly help speed up the use of S&T, and improve investment requirements.

Other reforms may be called for in export control policy. A better balancing of military and economic security requirements may be useful.

We need much better protection for the output of those who create new ideas and create new inventions, and this should be done through a strengthening further of the intellectual property laws. Stable money and responsible fiscal policies and an open trading environment also help assure the value of S&T.

But, perhaps most importantly, the government of the people should help insure the long-term health of S&T by investing in and improving the most fundamental element of that enterprise, recognized by Jefferson to be the bulwark of democratic freedom—the education of the people.

The entire pipeline, from primary school to graduate school, needs cleaning and rebuilding. To carry the analogy further, we need higher horsepower pump stations all along the line.

To compete globally, we must have an increasing flow of new knowledge, expressed through an increased number of well educated practitioners. The focus of final output is the research of our university, national and industrial laboratories. We need to nurture scientific education.

I would urge the Congress to continue its increased rates of support for research and education.

For similar reasons, I urge support of the President's proposal to double the National Science Foundation budget over the next five years, and the proposal to establish new, university-based inter-disciplinary science and technology centers, similar to the foundation's competitiveness-enhancing engineering research centers.

As Senator Hollings remarked earlier this morning, roughly, science alone is not enough. We must apply science as technology.

Technology, I might add parenthetically, is simply science that makes money.

One very encouraging thing about ERCs—and I do hope the new interdisciplinary centers—is the emphasis being placed there on manufacturing and process technology research.

In Japan, as we have heard, industrial manufacturing research is respected, and I would add that the commercial marvels of that nation have followed accordingly.

In the United States, however, research into these areas is not today highly valued. This is a destructive and totally uncharacteristic attitude for Americans, who have prized ingenuity since the foundation of the country.

Today, to our detriment, this attitude pervades the basic research community and our universities and our national laboratories.

Now, whatever mistaken notions of intellectual pride are at stake, one thing is most certainly at stake, and that is turf—real, financial turf. I, for one, would like to see a greater share of the Federal dollars that are available go into manufacturing and process technology research and a high regard expressed for the similar use of IRD allowances in the appropriate industries.

Perhaps, as an aside, we need the equivalent of an American Nobel Prize for manufacturing engineering.

The research dollar is a very highly leveraged dollar, an investment with a future return of thousands of percent. Today, technologies undergo fundamental change roughly every 3 years. So the future is right now.

Obviously, the need for immediate, closer cooperation between universities, government, and the private sector in such times cannot be overstated.

Allow me to close these remarks with a look at the government arm specifically created to provide a service for government and industry alike, the National Bureau of Standards.

The Bureau was established, like the National Science Foundation, to strengthen and advance the nation's science and technology; but unlike the Foundation, which deals in the soundness of the base, NBS provides a more immediately useful service—a basis for physical measurements and other metrology-related services.

It is no accident that today, NBS is a part of the Commerce Department.

Throughout the years, the Bureau has fulfilled its charter admirably, and I am very encouraged by the aspirations which exist within the Bureau to improve activities—for example, in the field of electronic materials. These are the sine qua non of electronics, telecommunications, avionics, and the information systems indus-

tries, with enormous leverage on national competitiveness, perhaps on national survival. And this is exactly the kind of initiative that the times call for.

To insure proper focus and contemporary direction, I do urge support of the budget request of the Bureau for 1988, with needed increases in process and quality control, high performance composites, bioprocess engineering, lightwave measurement technology, and computerized reference data, among many others.

Along with my support, however, I must express some concerns. One is the interface with industry. As the source of standard measurements, the Bureau must maintain close contact with industry. In a sense, NBS programs must take their lead from industry. But NBS must also strive to anticipte such needs.

Today, NBS communications with industry, while substantial, are insufficient and one-sided. Scientists and engineers from industry work at NBS as visitors and guest workers. But the "return match" is played much less frequently.

To address this situation, the Bureau should be allowed funds, perhaps matched by industry, for NBS visits and extended periods of NBS staff work at leading industrial laboratories. Such interchange could help the Bureau better understand not only the needs of industry, but the timeframe and the culture required for effective performance.

Only through a better understanding of what U.S. industry is facing, gained through the opening up of such a two-way street, can the Bureau do a better and more contemporary job of fulfilling industry's needs at today's global pace.

Subsequently, the Bureau could develop its own strategic calendar, perhaps looking forward 5 to 10 years, based on current trends. Today, however, the Congress is asked to approve programs for the Bureau for the next year with some indication of follow-on initiatives for the year following. There is very little long-term context.

My other major concern with the Bureau centers on staffing. It is not enough to come up with research into high leverage areas. The staffing must also be appropriate to the job.

Consider, for example, the ceramics division of the Bureau. Here there is real enthusiasm, collegiality, cooperation and excellence. The only problem is that there are not enough trained ceramists to help nurture the U.S. ceramics industry.

We need to see substantial cooperation in agreed plans between industry and the Bureau so that that funding increase for that and other initiatives have the needed, timely impact on the NBS constituency.

I urge you to see that the NBS staffing better matches the research thrusts and particularly to understand that we are cumulating responsibilities on the Bureau as new technologies are added.

The staff ranges from competent to brilliant. But we should not expect supermen or wonder women, and indeed we should pay them properly, sir, as you commented.

We need to grow more seed corn of competitiveness. This is science and technology educated people.

Senator RIEGLE. Let me interrupt you, if I may. I am going to ask you to try to finish in a minute, if you can, because otherwise we are not going to have time to hear everybody else.

Dr. CANNON. Yes, one minute.

There is no monopoly on brains. There is no frontier which can contain ideas.

After 35 years in the research and development business, I know that a 2-year lead is about as well as anybody can do, and in 2 years, we have to hustle to bring new ideas to reality.

That is where the science establishment needs a lot of stimulation and maybe some real pushing. The Federal initiatives to enable teaming do help the reduction to practice. We face a very real competitive challenge. The Bureau has a very, very important part to play.

And, as you have said, sir, we must all play our parts better.

[The statement follows:]

STATEMENT OF DR. PETER CANNON, VICE PRESIDENT—RESEARCH AND CHIEF SCIENTIST, ROCKWELL INTERNATIONAL CORP.

Good morning Chairman Riegle and members of the subcommittee.

I am Peter Cannon, vice president-research and chief scientist for Rockwell International Corporation.

I would like to thank Senator Hollings and Senator Riegle for graciously providing me with the opportunity to present my views on a subject which so affects the welfare of the nation. The views I shall express this morning are not necessarily those of Rockwell International. They are my own—the views of a scientist, manager of scientific research, and businessman with over 30 years of experience. For purposes of this hearing, I should also add that I spent part of the last 6 years chairing assessment panels for the National Bureau of Standards.

This year we celebrate the bicentennial of that document which brought this Nation into a more perfect union and thereby secured the blessings of liberty which today we continue to enjoy as no other people in the world. We celebrate the bicentennial of the Constitution of the United States of America. In celebrating this happy occasion, we rejoice in the freedom and the unprecedented prosperity which that Constitution has made possible.

A document of such profound historical consequence not only deserves our reverence, more importantly it obligates us to conduct our affairs responsibly, intelligently, and courageously. Thus, the bicentennial of the Constitution calls for sober thought—for cerebration if you will—as much as it calls for celebration.

Even now, as we enter our third century a free nation, we confront a number of challenges which are testing our ability and our willingness to remain free and prosperous. Many of these challenges, like the issues of poverty, health, war and peace, have been with us always. Others like the control of AIDS, crime, and pollution present us with newer tests. They all demand careful thought and considerable energy.

One such challenge may, for convenience sake, be termed "the competitiveness challenge." Upon our ability and our willingness to meet this challenge depends our standard of living, our ability to produce jobs, our capacity for economic growth and our ability to defend ourselves.

Thus, I am most pleased by the new emphasis both Government and the private sector are placing upon restoring the economic competitiveness of this Nation.

Congressmen from both sides of the aisle are finally coming together in a spirit of bipartisanship with proposals designed to tackle the tough challenges this Nation faces in terms of trade, technology, jobs, and education.

In addition, President Reagan recently outlined a six-part comprehensive program designed to enhance America's competitive edge into the 21st century. Happily, the President has already transmitted his proposal to Congress for consideration as the "Trade, Employment, and Productivity Act of 1987."

Such is the kind of energy we need, and the type of comprehensive approach we must have if American workers and business are to meet world competition head-on and win.

Of course this is not the first time a representative of the private sector has come before Congress to address the issue of competitiveness. And, if the truth be known, there are about as many definitions of competitiveness going around as there are kinds of witnesses.

As in the tale of the blind men touching the elephant, competitiveness means different things to different people. More often than not, these various definitions touch upon some piece of reality.

Thus, the prevalence of sometimes contending notions should not allow this real—very pressing—issue to be devalued. Americans must not make the mistake of Newsweek's Robert Samuelson of believing that competitiveness is a bundle of old matters dressed in new clothing.

Of course, there is truth to the notion that some businessmen are talking up competitiveness simply as a ruse in the hopes of forcing Congress to pass measures which will shield their businesses from foreign competition.

And, this is unfortunate not only because protectionist measures have a history of failing to do what they were designed to do—nor because they have a history of visiting upon us cures worse than the maladies they were designed to correct. No, what is most unfortunate is that the presence of such thinly-veiled opportunism in the competitiveness debate is obscuring the significant concerns of the issue and forcing otherwise sober thinkers like Mr. Samuelson to dismiss the entire matter.

Fortunately, this body need not be convinced that we face a very real competitive challenge. The "Japanese challenge" has received ample inspection and is itself the cause of so much of the recent activity I have acknowledged.

But I hasten to add that Japan is but one of the many nations which has taken over an increasing share of world markets. Indeed Europe, Japan and the rest of the Pacific Rim countries are presenting us with a challenge which is affecting every American industry from smokestack to high-tech, from agriculture to supercomputers.

In part, this is due to the fact that other nations had a lot of catching up to do. Closely connected to this point is the fact that science has now become a globally-held asset—it is ubiquitous. Try as you may, you just can't keep knowledge from crossing borders of new ideas from popping forth within borders—a notion which is a never ending source of disquietude for Soviet Communist Party officials and which should mitigate the fears and moderate the decisions of those well-meaning American officials who keep such tight reigns on our export capabilities.

In part, our diminished world presence is due to factors such as volatility in world exchange rates and unfair trading practices both of which I shall discuss later.

Thus, the economic challenge for America issues from a number of external factors which are often beyond its own power to control But, this challenge will be met only if we face up to an equally important set of internal factors.

We must meet both our internal and our external challenges if we are to enter the 21st century a free and prosperous Nation.

For brevity's sake, then, let me begin by defining competitiveness as that attribute which characterizes in greater or lesser degree a host of industrial, economic, demographic, and educational transactions and arrangements that assure an increasing number of jobs and a rising standard of living for all our citizens.

Competitiveness is the measuring characteristic par excellence for a world in which knowledge—and the science and creativity that accompany it—know no borders. The end of being competitive is thus plainly clear—healthy sustained economic growth.

America must be second to none in these matters or surely as night follows day, it will find itself in the unenviable position of England—a position of apathetic stasis and economic stagnation.

With this predicament in mind, let's take a closer look at America's most visible foreign competitor: Japan—the exemplar of our Nation's external challenge.

The first thing we should note in looking at Japan is unsurprising though pregnant with oft-overlooked meaning. Japan is a small island about the size of California but with five times the population and without the state's rich endowment of natural resources.

In modern times, Japan has been faced with a stark choice: export or die. Japan had necessity placed upon it by geography and demography. It has lived with the sort of predicament that America has up until recently had the luxury of avoiding.

Well, how has Japan done it? How has this small island nation become so successful at exporting? How has it acquired the second largest economy in the world?

Very deliberately. Without going into a lengthy historical review, suffice it to say that Japanese Government bureaucrats and business executives, surveying the ruins of World War II and assessing their future prospects, embarked upon a very

deliberate strategy whose aim was the construction of a technology-intensive, export-oriented industrial infrastructure. Nothing less than rapid industrialization was the aim.

Logic bid them to design a strategy to generate savings for use in capital investment. Japan avoided the more popular and detrimental paths that most nations have chosen.

Unlike nations such as Brazil and Mexico, Japan refused the option of heavy foreign borrowing. Unlike many third world nations, Japan also refused the policy option of allowing extensive direct foreign investment by multinational corporations. Finally, Japan spurned the industrialization path—a la Sweden and France—that emphasized state capitalism.

Instead, in pursuit of their goal of rapid industrialization, Japan adopted what Thomas McCraw of the Harvard business school economically terms a "pay-as-you-go" strategy.

This "pay-as-you-go" strategy was not so much a series of codified policies as it was an agglomeration of devices designed to promote habits of saving. McCraw points to five such devices.

First, by taxing interest payments and exempting from taxation most of the income from saving accounts, the Japanese Government penalized consumer borrowing and installment plan purchases while rewarding consumer saving.

Second, by requiring large cash down payments for housing purchases, the government forced prospective homeowners to save for long periods, thereby effectively delaying widespread home ownership and allowing for the growth of a pool of funds that could later be used for more significant industrial investment.

Third, through a compensation system that paid Japanese workers via proportionally large bonuses—in essence lump-sum salaries—Japanese companies encouraged employees to save.

Further, many will be surprised to learn that, until the 1970's, Japan maintained a public welfare system that by western standards appeared underdeveloped—a fourth critical savings-oriented device.

Fifth, and finally, through a rigorous system of capital controls, Japan prevented any substantial capital flight, thereby adding to the pool for domestic investment.

With such savings devices in place, Japan could accumulate the capital investment funds they needed to acquire the technology that would be the driving engine of the export-weighted economy. Japan decided to acquire its technology through a combination of four principal means.

First, Japan would "grow" its own technology by erecting a first-class educational infrastructure and through concerted and government facilitated R&D programs and a host of other "technology friendly" macro- and micro-economic means.

Second, they would "import" technology through joint ventures with high-tech American firms.

Third, they would buy the technology through licensing arrangements and royalty payments.

And, fourth, Japanese companies would establish a practice wherein they would purchase an American high-tech product, dismantle it, analyze it, re-engineer it and finally replicate it—that is they would "reverse engineer" our technology.

As I said, they undertook all four methods, but as you may have suspected, the Japanese relied more on the last two means for the relatively quick acquisition of expertise they sought and in fact achieved; and they depended upon the former two as long-range acquisition avenues.

The success of Japan's reverse engineering and technology-importation methods are patently evident and well-known—we see examples of it in our homes, in our jobs, in the cars we drive in, etc.

However, the full effects of Japan's decision to grow their own technology are just now beginning to dawn upon us. One way they decided to do this was, of course, through a strong education system. If you aren't already aware of the stunning accomplishments of the Japanese education system—and even if you are—I encourage those who haven't to read the excellent study on Japanese education recently released by Secretary Bennett.

While we should all be cognizant of the sometimes creativity-stanching rigidities of their system—shortcomings many Japanese recognize—we must still admit that we have much to learn from their example. I suggest that our educational community stop dismissing it as irrelevant to our culture and start focusing on those features that ask only that which could be asked of all humans everywhere—like good hard work.

Another aspect of Japan's choice to grow their own technology was the decision to make a national commitment—a truly strategic commitment involving government,

universities and industry—to a research and development capability geared to keep Japan at the head of the pack.

Many examples illustrative of the commitment that has been made in this respect could be cited, but three should suffice to bring home the point.

The first is Japan's "technopolis" plan, which is an attempt to create 19 high technology industrial centers—essentially 19 "silicon valleys"—by the early 1990's.

Each technopolis will boast a high technology industry and a university of research institute geared to advance the state of the art in that industry. The government is facilitating and encouraging these efforts through a variety of mechanisms including tax-depreciation allowances, business financing and construction of critical infrastructure.

The second example of Japanese commitment to the long term deals with research into the sort of advanced materials upon which the futures of our automobile and aerospace industries—to name only two—increasingly rely.

I have had the pleasure—and still do—of chairing a panel study for the National Academy of Engineering on needs and opportunities in materials science and engineering for the aerospace industry. In the course of our work, we have discovered that at one Japanese company alone, Nippon steel, over 700 scientists and engineers are engaged in forefront research on a variety of advanced composite materials. Seven hundred—such magnitude is astounding. Approximately 763 scientists are engaged in advanced materials research for the entire U.S. steel industry. Thus the efforts of only one Japanese company are effectively at parity will the efforts of an entire American industry.

The third and final example concerns the Japanese commitment to carving out a lasting position of dominance in the field of semiconductor microchip technology—chips being the very stuff which makes modern computers—well, modern.

Their commitment in this field has been impressive, involving university and government consortia, close corporate communications and collaboration between R&D functions and marketing functions, and a clear sense that the nation is in it for the long term.

For example, the ministry of international trade and industry, the muchly-touted if often oversold miti, has designated a number of projects in microelectronics requiring a decade or more of research before the products are even brought to the marketplace.

American chipmakers, for one, are still reeling from the results of these and other efforts. So are some 65,000 American workers who lost their jobs because of loss of market share. In less than five years, Japan has wrestled top market share from the U.S. in the vital integrated chip business.

Japanese R&D and other efforts have also positioned them for a leadership position in this industry into the future. In fact, a recent study for the national research council found that Japan now leads in several emerging technological areas which are absolutely key to future electronic and optical device development.

For practical purposes, figure 1 depicts roughly where the Japan-U.S. balance of power as regards high technology capabilities and strengths lies.

Recalling what I said about Japan's national commitment to R&D, you will rightly infer that those first two points listed on the American side—that is, basic research and breakthroughs and inventions—are characteristics that can now be added to Japan's side of the ledger.

Twice now, I've mentioned "other efforts" from which we are reeling and which are positioning Japan for future positions of leadership. I am, of course, merely using discretion in describing some of the more unfair aspects of Japan's infamous "targeting strategy". Other nations are using targeting strategies now; Japan is simply the leader.

Bruce Merrifield, the assistant secretary for productivity, technology and innovation in the Department of Commerce enumerates seven steps in the Japanese targeting strategy.

The first is to do just that, that is, target an industry for which there is a bright future—like semiconductor chips.

The second step is to concentrate the businesses through unreconstructed Darwinian tactics—that's my term—which tactics effectively fertilize the strong through government aid and let the weak die off.

In the third step, R&D objectives based on manufacturing engineering improvements are, in Merrifield's words, "parceled out to avoid redundant effort and the new systems are leveraged 80 to 90 percent with low lost capital."

Fourth, imports are closed off to further base-load economies of scale in the home market.

In the fifth step, a two-tier pricing system is established whereby incremental pricing puts all the costs into the first eight-hour shift for the home market, and the next two shifts are for export at substantially less. The next time you hear that the Japanese pay substantially more than we for the products they make, you'll know why.

Sixth, the product is forward priced below the existing costs of American companies.

And as a seventh and final step, the Japanese in some instances make use of export subsidies to cost way below our market cost. In the case of the 256K ram chip, they priced for export at about a third of our costs—the catch is—their costs are roughly equal to ours. Such practices are known in the vernacular as "flooding the market."

The downside of this approach is that in the long-term this is a very risky and potentially destructive game. Today, Japanese companies are operating under incredible debt loads that the owners of American companies would never put up with. This then is not really a good example to follow.

The upside of this approach, both theoretically and thus far in practice, is that market share is gained very rapidly until economies of scale catch up with the prices. And once market share is lost, it is very hard to regain.

Such predatory pricing must be ended.

For what is at risk is not only our ability to lead computer technology worldwide; nor our ability to lead the communications industry worldwide; it is more importantly, the jobs at stake, and perhaps most ominously, the jeopardy it places us in of becoming dependent upon foreign nations for the advanced electronic devices that constitute the very heart of the modern defense systems upon which the nations of the free world so heavily rely. I shall return to the matter of unfair trade momentarily.

I've already showed you some industry-specific results of Japan's post-World War II decision to become the world-class trader it has in fact succeeded in becoming.

Let me quickly review some of a more macro-economic order. From 1954, a year after occupation to 1971—the time of the final dismantlement of fixed exchange rates and just prior to the massive increase in energy prices, the gross national product of Japan experienced an annual percentage increase of 10.1 percent. From 1971 to 1985, the time of the first and second oil shocks, the annual percentage increase in Japan's GNP was 4.4 percent.

This is a remarkable economic feat. It is to be contrasted with the United States' GNP figures of 3.6 percent and 2.5 percent respectively. And for us, the 1954 to 1971 period was most certainly economically prosperous.

What were the consequences for the U.S. of Japan's rise? Figures reflect that in 1975 our trade deficit with Japan stood at 1.6 billion dollars while by 1985 that deficit had grown to 40.7 billion dollars.

As I said, Japan is simply the most frequently cited country in the Pacific rim that is challenging us in world trade. Thus from 1980 to 1986, our trade balance with South Korea, Taiwan, Singapore, and Hong Kong slid some 2900 percent.

U.S. high-tech goods have not been exempt from such figures. In 1980 our surplus in high-tech trade stood at 26 billion dollars. By 1985, that surplus had fallen to 4 billion dollars; and last year, for the first time ever, we experienced a high-tech trade deficit of some 2.5 billion dollars. In this same period, our high-tech balance alone declined some 489 percent.

Overall, in 1985, U.S. imports totalled 345.3 billion dollars, while exports totalled 213.1 billion dollars for a record merchandise trade deficit of 132.1 billion dollars.

The operative fact is that for each 1 billion dollars of trade deficit, the U.S. loses some 25,000 jobs. Thus, in 1984 alone, the most reliable figures indicate that our trade deficit resulted in a net market job loss of over three million workers. And it is said that the competitiveness issue lacks substance!

Well, what should the U.S. response to this Japanese led challenge be?

Some say the way to salvation lies in the further lowering and eventual stabilization of the dollar.

There is a certain core of truth to this argument for it cannot be denied that the overvaluation of the dollar in world currency markets in the first half of the 1980s was indeed a contributing factor to the trade deficit we suffer under today. And though the dollar's coordinated devaluation has led to less expensive American products in most overseas markets, the results are hardly what were promised. We must realize that something much more amorphous—something much more complex than price is at work here.

Others insist that all our woes will come to an end if we would only close off our markets for a while to foreign goods and "Buy American."

Now, I have already admitted that some nations, including Japan, have not only been flooding our markets but consistently shutting off their markets to our goods. I could cite numerous other examples of unfair trading practices like Brazil's exclusionary importation laws which prohibit the importation of a high-tech product if a similar product is made by even one Brazilian company.

I've also said that this practice must be ended. U.S. policymakers must be prepared to legislate measures that will result in a temporary balancing of the sorts of non-tariff trade barriers I have instanced. But let me stress that such measures must be quite specific—not sweeping measures that erect fences around large chunks of our economy.

Furthermore, they should be premised not on the notion of protecting an industry but on the notion of assuring reciprocal market access. And finally, such measures must not be enacted with the notion that they are permanent. I won't enter into the fray of exactly how long they such be in force—that's a question for our elected officials to tangle with. But I will say that, as a rule of thumb, a short time is better than a long time.

This is because a free and open trading environment is absolutely vital to the success of the American economy. After all, fully 70 percent of the goods we produce must compete abroad or against products from abroad and as a consequence it is a form of suicide to shut ourselves off from the rest of the world. In erecting wide-ranging trade barriers we run the risk of reprisal from those we intended no harm.

Thus, those of you who may be thinking that my argument on the virtues of free trade have gainsayed my earlier argument on bringing predatory practices to an end will now see that a policy based on reciprocal trade access is not in fundamental tension with free trade principles.

Similarly, it appears that the increasing interdependency of today's global economy—in terms of trade, currency markets, and other factors—requires a great deal of cooperation among the trading nations. And let me hasten to add that cooperation need not be in opposition to competition.

Indeed, our task as a trading nation is to balance the two so that we don't cut ourselves off from the rest of the world in a zealous attempt to compete any more than we would play the suckers to the world and allow ourselves to be run over in an attempt to be a friend to everyone.

Both the exchange controls route and the protectionist route are being touted as all-purpose answers to our problems. Both, as I have pointed out, are built up around a grain of truth, but they also are laden with burdensome and damaging baggage. Indeed, reflecting upon the capacity of such notions to strengthen our economy, one is reminded of Dr. Johnson's observation on the likelihood of a perfect second marriage: it was an idea, he said, that represented "the triumph of hope over experience."

At bottom each of these prescriptions share one major flaw: they both attempt to deal exclusively with America's external challenge and consequently both neglect the equally important internal challenge we face.

I've said a great deal about the successes which constitute Japan's challenge to the U.S. There are lessons to learn in looking at the strategy, as we have done, which made such success possible. Some of these lessons will come to light when we begin to analyze our own strategy, or lack thereof, for economic competitiveness.

And, on this note, I must say that we've been allowing ourselves to lose. This is nothing new—the young commission came to this conclusion three years ago when it pithily stated in its report to the president that America's "ability to compete is eroding."

Perhaps part of the problem with acting upon such knowledge is the responsibility it places upon us. We would rather "fix" our problems by bashing the Japanese or calling for currency intervention. But we must be willing to say with Cassius, that the fault lies not in the stars, but in ourselves.

The causes of our deteriorating capabilities are both numerous and chilling. They include insufficient development of scientific and technical skills in our labor force; a general macro- and micro-economic environment which dissuades innovation and risk-taking; deterioration in industrial and university plant; and generally, a failure to emphasize long-term investment because of short-term-profit-oriented myopia.

By way of a closer examination of the self-inflicted nature of our troubles, I would like to say a word or two about a key indicator of such troubles—productivity; then, a few words on a key determinant of productivity—technological innovation; and finally, a frank comment on the fundamental source form which our technological prowess springs—our educational system.

To compete in the world marketplace and thereby to maintain our standard of living requires us to be a highly productive nation. But, in the years 1973 to 1983,

U.S. annual productivity growth averaged a mere 0.3 percent while our competitors did 5 to 15 times better.

Now, as a scientist I take pride in the many accomplishments of my profession. Scientific and technological genius allow us to deter our principle adversary without matching him man-for-man, tank-for-tank, or plane-for-plane. Moreover, to a great extent, we owe our health and our high standard of living to the fruits of scientific discovery and technological innovation.

Indeed, the Department of Commerce estimates that technological innovation was responsible for 44 percent of all U.S. productivity increases since World War II. I should add that each high-tech job, on the average, creates anywhere from 5 to 10 support jobs in the service sector—a sector which now accounts for about 70 percent of our Nation's GNP. Finally, that technology is the engine driving world economies is a fact I hope has become crystal clear to everyone.

It is obvious that either technology isn't pulling its weight or its weight isn't sufficiently being pushed. I'm not playing a semantic game here and I don't believe anyone can accuse American scientists and engineers of being lax.

The point I wish to make is that technology cannot be taken for granted, but there is a case to be made that in this country it has been. Science and technology must be nurtured; but have they? They do not exist in a vacuum, nor can they successfully function if treated as if they did.

Instead, as Ralph Landau and Nathan Rosenberg point out in an excellent new book, *The Positive Sum Strategy: Harnessing Technology for Economic Growth*, technology "Functions successfully only within a larger social environment that provides an effective combination incentives and complementary inputs into the innovation process."

This is a key thought to which I shall return momentarily. For now, it is essential to note that the most important input that can be made to our scientific and technological enterprise is educated human beings—and it is here that our neglect becomes most apparent.

As figure 2 shows, the trends emerging with regard to our educational system are ominous. Let's take a closer look at the first and third points on the figure.

In the past two decades Federal investment in University Research Plant, that is facilities, land, equipment, etc. has declined in real terms by 95 percent. Certainly the causal connection between such figures and the fact that one-fifth of academic research equipment is obsolete could not be more concrete.

What is the concern with the numbers a rising percentage of foreign science and engineering students?

I have no quarrel with the fact that students come from other lands. Rest assured that the concern is not based on a form of nativism.

Two things make these numbers worrisome. The first is that unlike in days past the majority of foreign students are receiving the quality education they came for and then returning to their native countries. The second reason is closely tied to the first and it concerns the inherent and potentially dangerous dependency implied in such numbers. What do we do if there is a cutoff in the pipeline? Plainly we must have a stronger domestic pipeline.

Obviously, there are many variables in the competitiveness equation. Accordingly, any strategy which seeks to make this nation more competitive must address a board range of long-term and short-term variables. Despite what some may say, there is no quick or easy solution for reversing America's competitive decline.

Rather, what is called for is a coherent and comprehensive strategy that addresses the many variables that comprise our competitive standing in the world. Such a strategy for economic growth should be dual in structure involving major actions by both our public officials and the private sector.

I would now like to present this dual strategy for economic growth. Each program [figures 3 and 4] has 10 major points.

Rather than review each of the points on figures 3 and 4, I will merely touch upon a few I have not yet explicated.

The first point involves a more conscious effort to create not only a technology-friendly environment, but an environment also conductive to competitiveness and the nurturing of a technology-oriented society.

Two recent actions are noteworthy here and are to be replicated. One is the establishment of NSF's engineering research centers—an ingenious means of enhancing America's competitiveness through tangible encouragement of collaborative efforts between the Nation's research-driven businesses and its research-oriented universities.

The other is the passage of the technology transfer act of 1986, which for the first time gave our national laboratories incentives to work with industry thereby creat-

ing the opportunity to translate early findings into the industrial pipeline for innovation and exploitation. Among the many other needed actions, it would be nice if the same energy were put into strengthening the international protection of patents, copyrights and trademarks.

With regard to the third point concerning incentives, I would only remind you of the Japanese strategy and then point to the fact that we tax interest on savings, capital gains on stocks and dividend income. Further, our cost of capital is roughly three times higher than in Japan. In fact, the new tax law will effectively raise the cost of capital an average of 13 percent

With regard to points four and six, I have two outstandiang concerns. The first is read Lew Allen's National Academy of Science Study on Export Policy, the minute you can get your hands on it. As the report makes clear, the need for reform of U.S. export control policy is glaring. The second speaks for itself and it is that the general agreement on tariffs and trade now covers less than 7 percent of world imports, exports and capital flows. Our multinational arrangements are somewhat outmoded to say the least.

The most important fact about figure 3 is the one not explicitly mentioned. And that is the point that Government must play the role of facilitator for economic growth—a pro-active agent for change. Its rule must not be interventionist and certainly not that of a manager or director as is often called for in proposals for an "industrial policy".

One way that Government directly facilitates an environment for economic growth is through its support of scientific research in the university, industrial, and national laboratories

I strongly support the increased spending on basic research that has occurred over the past several years. And, as I have said, I also support efforts like the ERCs which take us closer to applied research. In fact, I would strongly support greatly increased Federal spending on manufacturing and process technology research—an area this country has pridefully neglected to its own detriment.

The research dollar is a leveraged dollar. It is not simply another expenditure; instead, like money spent on education, it represents an investment for the future and in times when technologies are undergoing fundamental change every 3 years, the future is now.

One Government arm specifically created to facilitate the environment by advancing science and technology was the National Bureau of Standards (NBS). By taking a closer look at NBS, we may discern the advantages of Government supported research, and those places where change is called for.

In its general charge to advance science and technology, NBS is similar to the National Science Foundation. However, unlike the foundation which ensures the soundness of the science and technology base through basic research grants, NBS provides a more immediately useful service for Government and industry—namely, a basis for the Nation's physical measurement system and other metrology related services. It is no accident that NBS is a part of the Commerce Department.

Through the years NBS has fulfilled its charter admirably.

In recent years, for instance, NBS has had an enormous impact on the very important field of materials science through its work on quasicrystals. The bureau's plans to enlarge its research activities in the field of electronic materials holds out the promise for an equally large impact on national competitiveness as progress in electronic materials holds the key to the global race in telecommunications, avionics, and information systems generally. Such a thrust is exactly what the times call for.

To ensure that proper focus and contemporary direction, I urge support for NBS' budget reguest for 1988 including increases in the areas of process and quality control, high performance composites, bioprocessing engineering, lightwave measurement technology, and computerized reference data.

Along with my support, however, I must express my concern.

One general problem is NBS's generally insufficient interface with industry.

In its role as source of standard measurements for the Nation, the bureau must maintain close contact and association with those who make constant use of such measurements: Industry. In a sense, NBS programs must take their lead from industry. The bureau must also strive to anticipate such needs.

In respect to "taking the lead", NBS communications with industry need to be strengthened. Both junior and senior industrial scientists and engineers work at NBS as visitors, but the "return match" is played much less frequently.

To address this situation, NBS must have more funding available to allow for visits and extended periods of study at leading industrial laboratories. Such inter-

change will help NBS better understand not only the needs of industry but the time frame for effective performance.

The next step then would be for the bureau to develop a strategic calendar which looked forward some 5 to 10 years based on current trends. At present, too much time is spent defining programs for the next year only.

My other major concern centers on staffing. It is not enough to come up with research programs however badly needed, the staffing must also be adequate to the job.

Take for instance the ceramics division of the institute for materials science and engineering. This division is excellent in many respects; the only problem is that there is a paucity of personnel actually trained as ceramists.

Without a substantial representation of ceramists, the science questions to be addressed by the proposed funding increase may not receive the expert attention which makes for breakthroughs. Thus, I urge Congress to see that NBS staffing better matches the bureau's research thrusts. NBS does indeed have a vital role to play in meeting the competitive challenges this country faces.

The private sector program [figure 4] includes actions that we can all play a part in initiating. Again, I shall only touch upon points 4 and 6 since my remarks have covered the essentials of the other points.

Globalization is an imperative for any American company which wishes to gain a position of leadership in its businesses. And effective globalization involves striking that balance between cooperation and competition to which I earlier referred. You need only recall the success of Japan's efforts to import and buy technologies.

American companies have a great deal to learn from Japanese efforts to compete on a global scale.

Some American companies are not doing badly in this respect. I am proud to admit that my company, Rockwell, is providing a sterling example for others to follow. Rockwell has major business operations in 25 countries. Approximately one-eight of the company's sales are outside the U.S. and we anticipate that sales growth in many non-defense business areas will occur fastest outside the country.

Our international business activities have been based on a strategy of growth by acquisition and joint ventures with native companies. For example, we now have five joint ventures in Japan covering a wide range of activities including automotive products, printing presses, and electronics. Part of our Asian strategy is to identify for co-development with local partners technologies which were initially developed in the Far East.

In fact, we recently opened an office in Tokyo called the Far East Technology Liaison Office. The sole function of this office is to identify Austral-Asian technologies of interest to Rockwell businesses and to assist in arranging for commercial development of those technologies. We are planning to undertake similar technology acquisition activities in Western Europe.

With regard to point six, I'm specifically thinking of such things as robotics, computer aided design, and computer integrated manufacturing. On CIM equipment, America is spending 16 billion dollars annually. CIM means less waste, greater savings, and shorter life cycles. Such retooling of American industry must continue if we are to be competitive in the 21st century. Indeed, "innovate, automate, or evaporate" may be said to be the rubric of the day.

But we must realize that merely replacing old equipment with new is not in itself sufficient. The new technology itself must be efficiently managed. A flexible manufacturing system, for instance, must be employed flexibility—it shouldn't be given the job of making only one kind of part thousands of times over.

On this point, American industry has a great deal to learn from the Japanese. Professor Ramchandran Jaikumar of the Harvard Business School has completed a study comparing the use of flexible manufacturing systems in the U.S. versus their use in Japan. He found that in the U.S., systems were producing an average of only 10 different types of parts while in Japan similar systems were averaging 93 parts. Furthermore, the Japanese were manufacturing 22 different types of new parts using flexible systems for every one new part the American did. In other words, American management are allowing flexible systems to be used inflexibly. Our management styles must change as technology changes.

The global competitive challenge is a real one—one which will require nothing less than the active, strategic cooperation of Government, industry and our universities. As Ben Franklin once said, "We must all hang together, or most assuredly, we shall all hang separately."

We must match competitive challenge with more as well as better work. Federal labs, universities, industrial scientists—all should seek patterns of more efficient, cooperative, timely commitment. And realistically, we need to grow more seed corn

of competitiveness—the seed corn of science and technology educated people in universities and industrial labs alike. Money must be found even in these difficult times to strengthen America's long suit of inventiveness.

There is no monopoly in brains. There is no frontier which can contain ideas. After 35 years in the R&D business, I know that a two year lead is about as well as anyone can do—and that in those two years, we have to hustle to bring new ideas to reality. That is where the science establishment needs a lot of stimulation and help. The Federal initiatives to enable teaming are exactly what's needed to help the reduction to practice and some real pushing won't seem amiss.

The challenge before us is bigger—its implications much graver—than sputnik which so galvanized this Nation. If we are to enter our second two hundred years with a bang instead of a whimper, we must meet both our external and our internal challenges head on.

As was recently asked in our nation's history, if not us who? If now now when? Thank you.

FIGURE 1.—HIGH-TECH BALANCE OF POWER

JAPAN	UNITED STATES
Applied research and development	Basic research
Incremental improvements	Breakthroughs and inventions
Commercial applications	Military applications
Process and production technology	New product design
Components	Systems integration
Hardware	Software
Predictable technologies	Less predictable technologies
Quality control	New functionalities
Miniaturization	New architectural designs
Standardized, mass volume	Customization

Source: *"The Positive Sum Strategy,"* National Academy Press, Washington, DC 1986.

FIGURE 2.—OMINOUS TRENDS IN THE MOST FUNDAMENTAL BASE: EDUCATION

⅙ of academic research equipment is "state-of-the-art"; ⅓ is obsolete; ⅓ is more than 10 years old.

Ph.D. production not keeping pace with the Nation's needs: U.S. universities award about 3000 Ph.D. Degrees in engineering—some 500 fewer than in 1972.

In 1970, ¼ engineering Ph.D.s went to foreign nationals; in 1985, ½ did.

University engineering faculties more than 20% below number needed to reach student-faculty ratios of the 1960s.

7% of U.S. undergraduates major in engineering compared with 17% in Japan.

American high school students take less course work in science and mathematics than their counterparts in other major countries and fewer courses than their parents about three decades ago.

Source: Science Indicators, The 1985 Report. National Science Board, National Science Foundation, 1986.

FIGURE 3.—SUPPORT TEN POINT PROGRAM FOR PUBLIC POLICY

1. U.S. Government as an active, committed partner.
2. Reduce the Federal budget deficit.
3. Incentives for R&D, capital formation, savings.
4. Update trade laws.
5. Modernize U.S. antitrust laws and interpretations.
6. Pro-American posture at GATT conference.
7. World Class Traders must share cost of global defense and foreign aid.
8. Temporary balancing of non-tariff barriers.
9. Long-Term elimination of all trade barriers.
10. Major initiative in education.

FIGURE 4.—SUPPORT TEN POINT PROGRAM FOR PRIVATE SECTOR

1. Modify American management doctrine.
2. Improve industries understanding of leadership.
3. Alter financial demands on American industry.
4. Design world class companies to compete in global markets.
5 Establish quality as America's competitive advantage.
6. Upgrade America's industrial manufacturing technologies.
7. Challenge accounting industry to modernize methods.
8. Support education as national initiative.
9. Emphasize industries key advantage—the human resource.
10. Establish new industry labor partnerships.

Senator RIEGLE. Thank you.

There are a lot of very constructive thoughts there.

Mr. Nemeroff, would you please proceed. But first, let me say if you can hold your comments to roughly five minutes, it will help us. I know that it is not easy to do, and we ourselves are the worst at it. But please try.

STATEMENT OF EDWARD NEMEROFF, PRESIDENT, NATIONAL CONFERENCE OF STANDARDS LABORATORIES, AND PRESIDENT, DATRON INSTRUMENTS, INC, ACCOMPANIED BY GEORGE RICE, PAST PRESIDENT, NATIONAL CONFERENCE OF STANDARDS LABORATORIES.

Mr. NEMEROFF. We will certainly try.

Good morning, Mr. Chairman. I am pleased to have this opportunity this morning to discuss with you the concerns of the domestic industrial membership of the National Conference of Standards Laboratories, and, more specifically, our views relative to the fiscal year 1988 NBS budget.

My name is Ed Nemeroff. I am President of the National Conference of Standards Laboratories, and President of Datron Instruments, Inc., in Stuart, Florida.

Accompanying me this morning is Mr. George Rice, who is Past President of the NCSL.

The NCSL is one of the world's largest technical societies dedicated to the field of calibration, standards, and metrology, specifically traceability. Although international in scope, our main membership is of U.S. origin.

Our membership is made up of both large and small companies, from academia, from the scientific, industrial, commercial and government laboratories.

We certainly appreciate these opportunities to express the views of the United States measurement community, and speaking on behalf of that concerned body, we thank you.

The National Conference of Standards Laboratories continues to be concerned about the delivery of measurement and calibration services by the National Bureau of Standards. Many of us are unable to meet the measurements, standards and calibration needs of our parent organizations because the National Bureau of Standards has been unable to provide us with vital measurement standards and calibration services.

This concern and the problems represented are certainly not new. However, as each year goes by, with only token efforts being made to halt the decline in this vital and primary function of the

Bureau, our concern is heightened and the problems have become more acute.

The Bureau's Congressionally funded budgets for measurement standards and calibration services have declined over the past two decades in constant 1965 dollars. This has occurred during a period of unprecedented advances in science, technology and manufacturing, and, more recently, during a time when the stated objectives of the current administration include increased international competitiveness and the stimulation of productivity, economic recovery, and growth.

American industry's measurements and standards needs are well documented and published, and have been extensively reviewed, not only by the Bureau, but others as well.

In late 1985, these ever-growing industrial measurement concerns and the importance that measurement standards and calibration services play in America's overall industrial quality scenario led to the development of three separate fiscal year 1987 initiatives of importance to the standards and calibration community.

The three Bureau fiscal year 1987 initiatives included:

One, $6.1 million for Process and Quality Control;

Two, $6.3 million for Millimeter and Microwave Standards; and

Three, $10 million for Fiber Optics and Electro-Optical.

Even in light of the aforementioned administration objectives, almost all of the funding for these fiscal year 1987 proposals were left on the cutting room floor. Each of these was considered essential when they were developed; they are even more important today.

We were concerned when they were not included in the fiscal year 1987 budget. We are even more concerned that the fiscal year 1988 budget does not address these critical areas at the proposed fiscal year 1987 levels.

For example, the process and quality control initiative in the fiscal year 1988 budget is only slightly over one-half of the $6.1 million originally identified. The fiscal year 1987 proposed initiative for millimeter wave and microwave was requested at $6.3 million. This budget has no funds at all in this critical area.

The proposed initiative for lightwave and fiber optics was for $10 million. This budget contains only $500,000.

The fiscal year 1988 budget for the National Bureau of Standards does address two of the primary areas of interest to the members of the National Conference of Standards Laboratories. The first is the $3.55 million process control and quality assurance initiative. Although we believe that the budgeted base funding for measurement and calibration services is too low across the board, and although it is clear that the $3.55 million falls far short of the identified national needs, we are compelled to endorse this token amount.

We would urge this subcommittee to seriously consider all of the needs and provide the additional funds which would contribute more substantially to halting what we observe as an unfavorable and damaging trend.

Our organization also endorses the lightwave measurement technology, fiber optics budget, of $500,000, to provide measurement technology and services in support of the optical fiber communica-

tions industry, although here, too, that amount falls short of the requirements.

Combined with last year's initiative in this area of $950,000, the two-year total only represents 15 percent of the identified needs.

The National Conference of Standards Laboratories believes the situation in the measurement standards and calibration services portion of the Bureau's mission has become so serious as to impede the orderly process in national productivity, competitiveness, and quality control, as well as seriously impacting this nation's defense programs.

We believe this mission underpins every aspect of the American economy. It needs to be given renewed emphasis and direction.

As we believe that the funding issue is absolutely vital, we urge you to carefully examine this budget to determine whether the proposed amount is really sufficient to carry out the measurement standards and calibration services mission.

We believe you will conclude that it is not.

We, therefore, strongly urge that the NBS fiscal year 1988 budget for this mission be increased to the level necessary to meet all of the identified requirements. This would require an absolute increase for Process and Quality Control, Millimeter Wave and Light Wave/Fiber Optics areas of $22 million.

Thank you, Mr. Chairman and members of the committee.

[The statement follows:]

STATEMENT OF EDWARD NEMEROFF, PRESIDENT, THE NATIONAL CONFERENCE OF STANDARDS LABORATORIES

Mr. Chairman and Members of the Subcommittee, I am pleased to have the opportunity today to discuss with you the concerns of the domestic industrial membership of the National Conference of Standards Laboratories and more specifically, our views relative to the FY 88 NBS budget proposal.

My name is Edward Nemeroff, I am the President of the NCSL and also President of Datron Instruments, Inc., Stuart, Florida.

Our organization has been privileged to appear before this Subcommittee on several occasions over the past few years during the NBS budgetary hearings. We certainly appreciate these opportunities to express the views of the U.S. measurement community, and, speaking on behalf of that concerned body, we thank you.

SUMMARY OF CONCERNS AND PROBLEMS

The National Conference of Standards Laboratories' domestic industrial membership continues to be concerned about the delivery of measurement and calibration services by the National Bureau of Standards. As we have stated before this Subcommittee in the past, many of us are unable to meet the measurement and calibration needs of our parent organizations because the National Bureau of Standards has been unable to provide us with vital measurement standards and calibration services. This concern and the problems represented are certainly not new. However, as each year goes by with only token efforts made to halt the decline in this vital and primary function of the Bureau, our concern is heightened and the problems have become more acute. The problems we see are not just caused by a lack of funding but we believe it is fair to say they have their genesis in the federal budget.

The Bureau's budget has remained essentially flat in constant dollars for many years. During this period the Bureau has taken on a number of new or greatly expanded roles (some by its own choice, others mandated by Congress or the Department of Commerce). Not many of these new roles were aimed at the delivery of measurement and calibration services. Inevitably, therefore, that part of the NBS budget devoted to the research and development of measurement standards and the delivery of calibration and measurement services has declined in constant dollars. It is our view that we have apparently lost sight of the original purpose in creating the Bureau in 1901—specifically the standardizing role provided through the delivery of measurement and calibration services.

CONTRIBUTING FACTORS

In examining the various factors that contribute to the Bureau's present plight, there appear to be two major determinants: (1) its inability to obtain adequate congressional funding, and (2) its inability to maintain the proper focus for those funds that are received. As cited earlier, the Bureau's congressionally funded budgets for measurement standards and calibration services have essentially declined over the past two decades in constant 1965 dollars. This has occurred during a period of unprecedented advances in science, technology, and manufacturing, and more recently, during a time when the stated objectives of the current Administration include increased international competitiveness and the stimulation of productivity, economic recovery, and growth! Why have we permitted this ongoing enfeebling of what many of us believe to be the primary mission of the National Bureau of Standards?

It is important to understand that the Bureau—like most industrial companies—has two distinct internal cultural factions. The first is the science faction (basic research) that normally receives high corporate, public, and political visibility and the second is the engineering faction which attempts to focus its efforts on the application of that scientific research data and technology for the benefit of the customer or the user. What we find is that the latter faction must often compete with the former for adequate funding. It is however, the latter engineering faction that transfers the technology for the betterment of our economy and the American public. I want to emphasize that is is important to be aware of this imbalance in public and political visibility as you deliberate NBS funding requirements.

We do not imply by this discussion that the science faction is unimportant. In fact, it is vital to the ability of the NBS to remain at the forefront of scientific endeavor. Only in this way can it create the knowledge upon which subsequent technology advances in the measurement and calibration areas may be based. We do mean to emphasize that the apparent invisibility of the engineering faction (specifically the measurement standards and calibration function) in no way makes it less important than its most visible counterpart.

American industry's measurement and standards needs are well documented and published and have been extensively reviewed not only by the Bureau, but by others as well. I need not belabor this Subcommitte with all the details of these surveys and studies today. It is perhaps sufficient to say that you—as well as the Bureau—are aware of these ever-growing industrial measurement concerns and the importance that measurement standards and calibration services play in America's overall industrial quality scenario.

The Bureau appeared to recognize these national measurement short falls (as the Department of Commerce Deputy Secretary, Clarence Brown, testified before a House Subcommittee 15 months ago), and was developing three separate FY 87 initiatives of importance to the standards and calibration community. The three Bureau initiatives included: $16.1 million for Process and Quality Control; $6.3 million for Millimeter and Microwave Standards and Calibration; and $10.0 million for Fiber Optics and Electro-Optical.

Unfortunately most were left on the cutting room floor. In light of this Administration's stated objectives of increasing our Nation's international competitiveness and the stimulation of productivity, economic recovery, and growth, it appears incredible that the direct relationship between national measurement standards and the achievement of such industrial growth objectives could then be ignored.

The U.S. National Measurement System consists of several thousand organizations, laboratories, and institutions all linked together, both voluntarily and by regulation. The system is absolutely dependent upon traceable linkage to the technically competent, credible, and *competitively neutral* National Bureau of Standards. As can be appreciated, this same National Measurement System is an integral part of every element of the U.S. economy. It underpins all of our scientific, medical, and industrial endeavors and provides for:

Equity in trade and commerce (both here and abroad).
Product quality and industrial productivity.
Universality or equivalency in engineering and production methods.
Progress in science and technology.
Health and safety of all Americans.
And lastly, the security of the Nation.

It seems imperative therefore—now as well as in the foreseeable future—that national measurement standards must always be a conscious element of this Nation's industrial growth policy. To believe otherwise is folly.

LEVERAGING THE U.S. ECONOMY TOWARDS COMPETITIVENESS

We believe one of the Bureau's primary contributions to the U.S. economy is to leverage the productivity and the quality of industry's technology-based activity. A very important example of how this type of leverage works in reverse (lack of government lab involvement) can be cited in those emerging technology areas where adequate national traceable standards often do not exist. Industry must, therefore, substantially over-design and over-test its products in an effort to assure performance specifications. In addition, each company is driven to develop its own measurement technologies which are frequently classified proprietary and not available to other companies. This added cost burden does not enhance this nation's competitive position or our ability to penetrate international markets, not to mention halting the decline in our domestic marketplace. To cite as a positive example of how Federal funding of NBS has provided—and will continue to provide—effective leverage, the lightwave technology industry and fiber optic area have already benefited from ongoing research at the Bureau in laser metrology. We understand the Bureau's past research and development efforts in the Cryoelectronic metrology area have also contributed in a positive way to this emerging technology. As can be seen, the benefits resulting from this proximity of resources and shared talent can only be achieved because of a centralized development institution such as the Bureau. And of course, the diffusion and the dissemination of that technology and that research information back to U.S. industry is likewise broader and also more rapid. To the extent that measurement technologies are only useful if adopted by an entire industry in the form of a standard, this broad and rapid release and diffusion is certainly beneficial to the overall national economy, as well as having a direct impact on our international competitiveness.

In the recent past, some have suggested that the private sector—primarily U.S. industry—should play a more active role in the research and development of measurement standards in support of our technology-based economy. It is assumed that the principle driver behind such policy suggestions is an effort to reduce the federal outlay and hence improve the national deficit picture. Although on the surface such a policy may appear to have some merit, the general application of such a policy to the only Federal agency dedicated to facilitating the use of technology for national economic benefits, rather than for advancement of a specific mission, is counter-productive.

It is imperative that your Subcommittee consider—in depth—the economic benefits which accrue from investments in the Bureau. As stated earlier, national measurement standards must always be a conscious element of this Nation's industrial growth policy. We strongly advocate the government's role in supporting measurement standards for U.S. industry and submit the following comments and observations.

When a few U.S. businesses do develop industry-wide measurement technologies and consensus standards, they rarely have the required credibility with other marketplace participants since they were not developed by an institution perceived to be technically competent, or at least competitively neutral. Only an institution such as the National Bureau of Standards can effectively act as a neutral third party when there are marketplace disputes.

We would also cite the many National Bureau of Standards' formal measurement reciprocity agreements with other countries' national standardizing labs. Such agreements are entered into in an effort to reduce non-tariff trade barriers and enhance international competitiveness in the marketplace.

The current thrust in this Administration—which appears to have the support of the Congress—is for government to become more involved in those activities which contribute to, or improve, American industry's international competitiveness. Probably the single most important enabling factor in manufacturing—whether it be automobiles, electronics, chemicals, etc.—is the existence of standards. That is, standards do not merely facilitate production, they enable production. Industry conducts research, develops technology and creates new products, materials and processes. All such activities absolutely depend upon precise, accurate and credible measurements. Quality measurements depend upon the existence of standards. In these regards, research and development of standards by the Bureau must proceed concurrent with related research in industry. Only in this way can standards be available when research technology is transitioned into manufacturing processes. Whenever the development of adequate standards lags the development of new technologies, or new products, the only certain result is that whatever competitive edge may have existed rapidly disappears.

In summary we also observe that virtually all industrialized countries have strong government-supported and subsidized standards institutions. The NCSL organization believes it is absolutely essential that this country also have in place a federally supported—and adequately funded—national standards laboratory which is not only recognized as a credible institution, but also one that is competitively neutral. We believe it is equally important that this country has a cohesive and coherent National Measurement System made up of private sector laboratories whose actions and procedures can be guided by—and referenced to—that federal facility. As a Nation, we cannot permit—nor can we afford—any erosion of public confidence in the U.S. National Measurement System.

FY 88 BUREAU FUNDING ISSUES

Earlier we cited three proposed FY 87 initiatives that had been developed by the NBS as a means for reversing the unfavorable trends recognized by most observers. Each of these was considered essential when they were developed—they are even more important today. We were concerned when they were not included in the FY 87 budget. We are even more concerned that this FY 88 budget does not address these critical areas at the proposed FY 87 levels. The Process and Quality Control initiative in this FY 88 budget is only slightly over half of the $6.1 million originally identified. The Millimeter Wave/Microwave proposed initiative requested at $6.3 million—this budget has no funds at all for this initiative. The proposed initiative for Lightwave/Fiber Optics was for $10.0 million—this budget contains only $0.5 million.

The FY 88 budget for the National Bureau of Standards does address two of the primary areas of interest to the membership of the NCSL.

1. PROCESS CONTROL AND QUALITY ASSURANCE

This initiative includes the following prioritized projects:

	($ × 1,000)
1. Primary Frequency Standard R&D	$438
2. High-pressure Measurements	305
3. AC & DC Voltage	441
4. Randon Measurements	246
5. High-temperature Thermometry	174
6. Low-frequency Measurements	967
7. Electrical Documentation & Training	255
8. Neutron Dosimetry	246
9. Electrical Resistance Measurements	306
10. Primary Temperature Facility	172
Total	3,550

Although we believe that the budget base funding for measurement and calibration services is too low across the board, and although it is clear the $3.55M for this initiative falls far short of identified national needs we are compelled to endorse this token amount. We would urge this Subcommittee to seriously consider all of the needs and to provide the additional funds which would contribute more substantially to halting the unfavorable and damaging trend previously noted. We believe that it is imperative that the initiative be fully supported throughout the entire legislative process. In the past several years, it has been amply documented that U.S. industry has come to recognize not only the importance of implementing new process and quality control methods and techniques during manufacturing, but also, to begin to recognize the equally important relationship that standards and accurate measurements have in that total quality scenario. Industry's renewed quest for quality and increased productivity in response to intense foreign competition is—and will be—heavily dependent upon the Bureau's planned capability recovery in these high priority areas.

2. LIGHTWAVE MEASUREMENTS TECHNOLOGY—FIBER OPTICS

Our Organization also endorses the Bureau's budget item of $500,000 to provide measurement technology and services in support of the optical fiber communication industry, although here too, that amount falls short of the identified needs. Combined with last years initiative in this area of $950,000, the two year total represents only 15% of the identified needs. The economic advantages of this emerging industrial technology over the more traditional hard wire communication systems

makes this an attractive industry for the U.S. government to promote and stimulate. The Bureau's proposal to develop data, measurement methods, and standards for defining component performance, as well as characterizing the materials from which these components are made, will enhance the U.S. lightwave technology industries' competitive position in the international marketplace. Failure to seize this opportunity now will lead to another disaster in the future similar to our current position in millimeter wave measurement standards technology.

CONCLUSIONS AND RECOMMENDATIONS

Mr. Chairman and Members of the Subcommittee, the situation in the measurement standards and calibration services portion of the Bureau's mission has become so serious as to impede the orderly progress in national productivity, competitiveness, and quality control, as well as seriously impacting this Nation's defense programs. We believe this mission underpins every aspect of the American economy—it needs to be given renewed direction.

As we believe that the funding issue is absolutely vital, we urge you to carefully examine this budget to determine whether the proposed amount is really sufficient to carry out the measurement standards and calibration services mission. We believe you will conclude that it is not. We, therefore, strongly urge that the NBS FY 88 budget for this mission be increased to the level necessary to meet *all* requirements. This would require an absolute increase for Process and Quality Control, Millimeter Wave, and Lightwave/Fiber Optics areas, of $22M

Thank you for the opportunity to express these concerns. I'd be pleased to respond to any questions you might have.

Senator RIEGLE. Thank you very much. I appreciate your effort to stay within our time constraints and still say a lot of important things.

Mr. Bay.

STATEMENT OF ROBERT D. BAY, IMMEDIATE PAST PRESIDENT, AMERICAN SOCIETY OF CIVIL ENGINEERS, ON BEHALF OF THE AMERICAN ASSOCIATION OF ENGINEERING SOCIETIES, NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, AND SOCIETY OF FIRE PROTECTION ENGINEERS

Mr. BAY. Thank you. I am Robert Bay. I am the immediate Past President of the American Society of Civil Engineers.

I cannot help but observe today that I am pleased to be an engineer witnessing to you on Saint Patrick's Day. Saint Patrick is the patron saint of engineers, and he is credited with driving the snakes out of Ireland. I am sitting here today to help the National Bureau of Standards keep from being snake-bitten by the budget cuts that are proposed, and, as a matter of fact, the construction industry as well.

I am pleased to be here because I am representing ASCE, an organization of 110,000 engineer members, and the American Association of Engineering Societies, AAES, which is made up of 22 different professional engineering organizations, and the National Society of Professional Engineers, which has 75,000 members, and the Society of Fire Protection Engineers, who have 3,100 members worldwide.

I want to thank you for the opportunity to be here to testify on this administration's budget for the National Bureau of Standards. I come to you with some consternation because the budget that we have been presented, the request for the Center for Building Technology and the Center for Fire Research, is inadequate. In the four previous fiscal years, the Administration has zero-funded both the

CBT and the CFR only to see this subcommittee and Congress restore those cuts.

The exception to this pattern occurred last year, when we thought we had an agreement with the Administration to accept a half million dollar cut in each one. Senator Danforth brought up the same subject. It appears now that we have the new budget where there is some good news and bad news. The good news, of course, is that they are not zero-funded, as they were in other years. The bad news is that they practically cut the budget in half and they are going to combine CBT and CFR in 1988.

So, the societies which I represent here today are very concerned with this kind of loose play on what we thought was an agreement.

We also want you to know that in our view, to assume the important research activities of the CBT and CFR, if they are terminated or drastically reduced would be a very, very tough thing for the private sector. They cannot simply assume those tasks. Their curtailment would cause great concern at ASCE, particularly in the light of the expressed commitments by the Administration and Congress to enhance the U.S. technological development and improve the U.S. economic competitiveness. We have heard a lot in testimony about that today.

The National Bureau of Standards building research improves the usefulness, safety and economy of buildings and enhances the international competitiveness of the U.S. construction services and products.

The National Bureau of Standards fire research provides the scientific and technical bases for reducing fire losses and the cost of fire protection.

If Congress approves these ill-advised budget cuts, building research and fire research efforts would be dramatically reduced in scope.

At a time when we should maintain, if not strengthen, the technical quality of the construction industry, domestic and international markets for U.S. construction services and products are being lost to foreign competitors with strong R&D bases.

The technical societies that I represent want the Congress to know that we strongly support both of these centers and oppose the merge and slash budget request that was put forth by the administration.

During the hearings in recent years, numerous statements were filed on behalf of a variety of organizations that stressed the valuable role performed by these two centers. The unique laboratory facilities and the expert professional staffs of these two centers are valuable public resources and should be husbanded, and strengthened, not diminished by budgetary concerns.

The Center for Building Technology provides a uniform base of information and serves as a unifying force for this entire industry. Due to the industry's size and its diversity, it is difficult to imagine any institution, in either the private sector or at the State level, that could duplicate these efforts adequately and distribute the findings on its own. This interdisciplinary laboratory also integrates complex technical issues in a way that more narrowly focused proprietary research institutions cannot carry out.

While the societies I am representing today commend and share the commitment to reduce Federal budget deficit, we also feel compelled to warn against careless cuts in essential programs that will not be and cannot be duplicated by the private sector. The services provided by these two centers are invaluable to an important segment of our economy, the building industry.

On behalf of the professional societies represented here today, I ask Congress to preserve this vital support.

Thank you very much.

[The statement follows:]

STATEMENT OF ROBERT D. BAY, IMMEDIATE PAST PRESIDENT, AMERICAN SOCIETY OF CIVIL ENGINEERS ON BEHALF OF THE AMERICAN ASSOCIATION OF ENGINEERING SOCIETIES, NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS, SOCIETY OF FIRE PROTECTION ENGINEERS

Good morning Mr. Chairman and members of the Committee, I am Robert D. Bay, Immediate Past President of the American Society of Civil Engineers (ASCE), which is headquartered in New York City. On behalf of ASCE, the American Association of Engineering Societies (AAES), the National Society of Professional Engineers (SNPE), and the Society of Fire Protection Engineers (SFPE) representing over a half-million engineers, I thank you for the opportunity to testify on the Administration's budget request for the National Bureau of Standards (NBS).

The Administration's fiscal year 1988 budget proposal calls for merging the Center for Building Technology (CBT) and the Center for Fire Research (CFR) and drastically cutting available funds for these unique and important programs. The Administration proposes to reduce NBS building research and fire research to $5 million base funding in fiscal 1988, down 50% from $10 million in fiscal 1986.

It was less than one year ago, Mr. Chairman, that Congress agreed to reduced funding for CBT and CFR at the level of $9 million in fiscal 1987, in return for the Administration's agreement not to propose further funding cuts for building and fire research. Release of the Administration's budget indicates that this agreement has been broken, a development that ASCE, and the other organizations represented here today, view with great concern.

As in previous fiscal years, when the Administration proposed outright termination of CBT and CFR, the rationalization for merging and cutting these research programs is that the resulting void will be filled by the private sector or state and local government. This rationalization, which this committee and the Congress have rightly rejected in recent years, belies the numerous statements filed on behalf of a variety of organizations that stressed the valuable role performed by the Centers for Building Technology and Fire Research. The continued budget assault on CBT and CFR is, indeed, perplexing if not alarming, particularly in light of the Administration's expressed commitment to improving U.S. economic competitiveness and technological development and excellence. Foreign competitors continue to strengthen their position in the construction industry through increasing research and development. NBS building and fire research improves the usefulness, safety and economy of buildings and enhances the international competitiveness of U.S. construction services and products.

Mr. Chairman, the professional societies I represent today want Congress to know that we support, without equivocation, full funding for CBT and CFR at the fiscal 1986 level of $10 million. The specialized laboratory facilities and expert professional staffs of the Center for Building Technology and Center for Fire Research are essential public resources that should be preserved, and not destroyed.

CENTER FOR BUILDING TECHNOLOGY

The Center for Building Technology is the national building research laboratory. It performs field, laboratory and analytical research to develop measurement techniques and to evaluate the performance of construction materials, components, and systems. The program includes substantial efforts in advanced computation and automation, structural engineering, earthquake hazard reduction, building physics, materials and equipment. Engineers need sound technical information to make responsible and cost-effective decisions in the building process.

CBT is the only research program that integrates complex technical issues affecting the vast building industry. Despite the fact that it amounts to about 10% of the

GNP, and that almost two-thirds of the nation's wealth is invested in constructed facilities, the building industry is quite fragmented. Because of the industry's size and diversity, it is difficult to imagine any institution in the private sector or at the state level duplicating CBT's efforts or adequately distributing the findings on its own. This interdisciplinary laboratory also integrates complex technical issues in a way that more narrowly-focused proprietary research and development cannot.

Some of the unique and valuable aspects of the CBT are:

Unique and comprehensive facilities such as a tri-directional structural test laboratory, 12-million-pound testing machine, environmental chambers, guarded-hot-plate and calibrate hot-box, plumbing tower, anechoic and reverberation chambers;

An integrated, nonproprietary program for removing technological market barriers to the construction industry as well as reducing unnecessary or ineffective building regulations without compromising essential levels of safety. This is the major technical information source for the development of voluntary standards by groups such as ASCE;

A quality assurance program for 650 public and private laboratories used by designers, owners, builders and state and local governments responsible for building and transportation.

CBT also provides the authoritative laboratory support for federal agencies that need assistance in developing criteria for the design, construction and maintenance of their facilities. Although we cannot offer solid statistical evidence, the technical support from the CBT provides the federal government with significant savings in the lifecycle costs in the operation and maintenance of its buildings.

The following case illustrates the vital role CBT provides to the building industry. On January 1, 1985, the management responsibility for the ANSI (American National Standards Institute) A58-1984 Standard, "Minimum Design Loads for Buildings and Other Structures," was transferred from CBT to ASCE. This standard is the only nationally recognized voluntary concensus on structural loads in the United States. It is widely used as a resource document by other codes and standards groups, regulatory authorities and engineers confronted with unusual design situations not covered by building codes.

Though management of the Standard will now reside with ASCE, and thereby with the private sector, CBT will continue to be the principal source of new technology to update ANSI A58. CBT programs such as Wind Loads on Buildings, Seismic Design Criteria, Floor Loads, Fire Loads, Reliability Analysis and Design Analysis have been and will continue to provide invaluable input fo the standard. Without future technological support by CBT programs, the future of this important standard will be seriously compromised.

During the past decade, inflation and budget cuts have significant reduced support for NBS building research. Moreover, Federal agencies with building-related programs have curtailed funding for research. NBS has also received new responsibilities such as earthquake hazards reduction and structural failures investigations, but without the benefit of additional resources. Despite budget difficulties, CBT has commenced research in areas critical to U.S. competitiveness in construction, including advanced computation and automation in building design, construction and use; automatic controls on building service systems; and indoor air quality. Unfortunately, research has been eliminated in other areas including foundations and geotechnical engineering.

CBT's recent accomplishments are many, they include: the first full-scale laboratory test in the U.S. of a bridge column subjected to simulated earthquake; the 1985 Mexico earthquake investigation; and a standard approved by ASTM for estimating the inplace strength of concrete. During the current year CBT will develop probabilistic design criteria for glu-laminated and engineering heavy timber structural elements taking into account load duration and damage accumulation. The criteria will be included in a pre-standardization document of ASCE.

Maintaining the technical quality of the U.S. construction industry is vital to the quality of life, public safety, and U.S. economic competitiveness. The U.S. can ill afford to lose domestic and international markets for U.S. construction services and products to foreign competitors with strong R&D bases. As the principal source of non-proprietary R&D for the construction industry, it is imperative that we sustain the NBS building research program.

CENTER FOR FIRE RESEARCH

The Center for Fire Research also contributes to public safety in a way that no privately-funded research effort could. CFR explores the processes that initiate, propogate and suppress real fires. As a result, realistic material test methods of fire

control and extinguishment can be developed. Like CBT, CFR does not promulgate or enforce standards or regulations. Instead, it provides technical support to voluntary standards and model codes groups, engineers, the building industry and fire organizations.

CFR is the world leader in the development of mathematical fire models and computer simulation. Given the disturbingly high fire death rate in the U.S., the importance of CFR programs cannot be overemphasized. Despite an improved U.S fire loss record over the last decade, each year U.S. fires result in over 6,000 deaths, 200,000 injuries, and $7.5 billion in property losses.

A drastic reduction in CFR funding, as proposed in the Administration's budget, would seriously impair a number of salient CFR activities including: technical assistance to over 100 standard-writing and code committee; the fire research grants program at U.S. universities; information to the building industry on fire safety technology; research on combustion product toxicity, which accounts for 80% of all fire deaths; research directed at reducing fire protection costs through improved codes and standards and less redundancy in fire protection; and research into new products, materials, and practices that often introduce new hazards.

If the specter of eliminating lifesaving opportunities does not deter efforts to curtail the CFR, the cost-saving implications should persuade a budget-conscious government to reconsider the proposal. Fire-safe building design techniques can save money for all sectors of our society. Through use and implementation of scientifically-based models and evaluation tools, CFR is attempting, by the end of the century, to reduce fire deaths by 3,000 per year and fire protection costs by $15 billion per year. Mr. Chairman, the budget request for CFR is at best, harmful to the economic interests of the American people, and at worst, life-threatening.

NBS officials can better discuss CFR's recent accomplishments, than I, but several activities are noteworthy: the Fire Simulation Laboratory, Computer Programs for Fire Engineers, Fire and Smoke Hazard Assessment, Gas and Oil Well Blowout Fires, and Dyed Salt Water Smoke Simulation.

The societies represented here today commend efforts to reduce the federal budget deficit, but we must also warn against the myopic reduction of essential programs that will not be duplicated fully by the private sector.

The services provided by the Centers for Building Technology and Fire Research are invaluable to an important sector of our economy, the building industry. On behalf of the professional societies represented here, I urge Congress to preserve these vital programs.

Mr. Chairman, this concludes my statement. Again, thank you for the opportunity to appear here today. I will be happy to answer any questions.

AMERICAN SOCIETY OF CIVIL ENGINEERS

The American Society of Civil Engineers (ASCE), founded in 1852, is the oldest national engineering society in the United States. Membership, held by 110,000 individual professional engineers, is about equally divided among engineers in private practice; engineers working for federal, state or local governments; and those employed in research and academia. The society's major goals are to develop engineers who will improve technology and apply it to further the objectives of society as a whole, to promote the dedication and technical capability of its members and to advance the professional and economic stature of civil engineers.

AMERICAN ASSOCIATION OF ENGINEERING SOCIETIES

The American Association of Engineering Societies (AAES) is a multi-disciplinary organization dedicated to advancing the knowledge, understanding, and the practice of engineering in the public interest. Located in Washington, DC, AAES includes 13 member societies, 6 associate societies, and 3 regional societies representing over 500,000 engineers in industry, government and education.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

The National Society of Professional Engineers (NSPE), is a professional society, representing more than 75,000 engineers of all disciplines nationwide. The members are organized into 54 state and territorial societies and 535 local chapters, and work in industry, education, private practice, construction, and government.

SOCIETY OF FIRE PROTECTION ENGINEERS

The Society of Fire Protection Engineers (SFPE) is the international technical society for engineers involved in the multifaceted field of fire protection engineering.

SFPE has 3,100 members located primarily in the United States, including engineers in private practice, in industry, in government, in manufacturing and installation of fire protection equipment, as well as technical members of the fire and casualty insurance industry. Fire protection engineers largely determine fire safety for all Americans through their impact on the designs of buildings and plants, both public and private, and their contribution to setting codes and standards. To achieve cost effective, relevant and engineers fire safety requires a solid scientific, technological base.

Senator RIEGLE. Thank you very much for your testimony.

Senator Danforth.

Senator DANFORTH. Thank you, Mr. Chairman.

Dr. Cannon, I just want to say in passing to you that I thought your testimony was very useful. I wish you had been here last year, when we were considering that no-good tax bill, when we reduced the research and development credit and placed institutional caps on tax exempt bonds for major research universities, and made venture capital less attractive than it had been heretofore.

Maybe we would have gotten more than 23 votes against that no-good bill had we had your testimony at that time.

Dr. CANNON. Senator, when is the next date?

Senator DANFORTH. What is that?

Dr. CANNON. When is the next hearing on that subject? I will be back.

Senator DANFORTH. I'm ready.

Mr. Bay, let me ask you this. You are a Kansas Citian?

Mr. BAY. Yes.

Senator DANFORTH. Your city, about six years ago, was the site of a major disaster relating to a hotel, and I believe after that disaster the National Bureau of Standards came in to examine the cause and to try, both to determine what the cause was for the sake of making the record clear, and also, hopefully, to provide greater knowledge in the future.

That was one specific example, wasn't it, of the desirability of having the Center for Building Technology be a first-rate operation?

Mr. BAY. Yes. Very definitely.

Senator DANFORTH. The administration says that these are fairly small budget cuts by government standards. They say that these could just be picked up by the private sector.

What is your response to that?

Mr. BAY. As I stated in my testimony, I do not think that it is possible. The main reason is that the competitiveness of products available and the competition by foreign contractors, make the margin of profit are very small. There is little left for research. If there is any research, it is very proprietary and in a very narrowly focused area. It does not deal with the systems.

I remind you that on projects that have had trouble in the United States that the trouble has been in the connections—I call it connections—but I am really talking about an assemblage of materials and a computer applied application to assemblage of these materials in a unique way that was not contemplated when all those products were developed—each in its own way. Nobody took into consideration the joint, the combined effects of all of those materials being joined together.

That is where our problems lie. We need research.

Senator DANFORTH. Would you explain to us how the work of the Center for Building Technology and the Center for Fire Research have any effect on America's international competitiveness?

When we think of competition, generally we think of products that are sold or goods that go back and forth across international lines. How does this have an effect on international competition, in your view?

Mr. BAY. Well, one of the things that we have to understand is how fire propagates, how it affects structures, how people who are in those structures have their lives endangered. Research gives us an opportunity to examine new systems and to develop materials to provide life-safe buildings. The private sector can use this basic research to develop products and services.

The other thing, of course, is to be competitive. We have to develop construction robotics and other computer-applied construction techniques to enable us to do things faster. The Bureau of Standards is contributing significantly in this area to help us provide opportunities to make us more competitive in foreign markets.

Construction is one of our major industries. A lot of the work is overseas.

Senator DANFORTH. Does your firm compete internationally?

Mr. BAY. Yes.

Senator DANFORTH. Thank you, Mr. Chairman.

Senator RIEGLE. Thank you, Senator Danforth.

Mr. Cannon, I want to echo the remarks of Senator Danforth. I thought all of your presentations were very helpful to us, but I particularly like the emphasis, Mr. Cannon, in yours and the broader sense of some of the other structural barriers and problems that we face.

I like particularly your comments on education.

Mr. Bay, you are a civil engineer, and you can appreciate this. I am struck by the fact that Japan today is running up nearly a $70 billion trade surplus with us. It is producing twice the number of engineers per capita than we are. Of course, this does not just refer to people coming out the end of the pipeline with advanced degrees. It goes all the way back down through the educational system.

I will give you a statistic which I heard just recently, which really sort of made my blood run cold, just thinking in American terms.

It is this. The high school drop-out rate in Japan today is 2 percent. Across America, our high school drop-out rate is about 29 percent. It is ten times worse than it is in Japan. That is just now the high school drop-out rate.

In my home city of Detroit, the high school drop-out rate at the present time is running at 70 percent.

If you think of this as an analogy about the problems that we face in manufacturing cars and trucks and you think of Detroit and Tokyo, in a sense, it starts to capture part of this problem. If we have a comparative high school drop-out rate of 2 percent on the one hand and 70 percent on the other hand, we are in trouble.

I think we can probably have a lot of good process engineering and a lot of good design engineering. But if those fundamentals are that far out of line, it seems to me that we are in trouble, that we

are going to remain in trouble, and probably sink into greater trouble.

So, clearly, we need to get a focused national discussion, a debate. We have an opportunity to do that because we are coming to a point this year and next year where we are going to be selecting a new president. That Presidential selection process, regardless of who it happens to be or which party, I think gives us an opportunity to have a national discussion with ourselves, as a self-governing citizenry. We can bring issues up on the table to look at, to discuss, to evaluate, and to see what we think, where do we stand, what does have to be the focus, where should we put our emphasis.

We have a lot of competing priorities these days. We have an age problem and there is a need for research money there. We have a desire by some to build the "Star Wars" program, and that is very expensive. In our subcommittee here, we have the problem of what to do within the NASA program. All of the choices involve dollars and resource commitments.

So I think what you gentlemen helped to do today, and the others before you, is to frame the question of some national choices. The very difficult national choices that we face and how we undertake them, once we have made our choices. We must see that we are able to perform them properly. And finally, how do we find both the resources and then the capacity to go ahead and follow through on these things?

It seems to me that if the education side of it, just for one, is not in place and if we do not get those pumping stations, as you suggest, along the line, starting probably from pre-school all the way through to graduate school, we are in real trouble and will remain in real trouble.

We are going to adjourn here because we must go to another meeting.

I don't know if any of you wants to make a final comment with respect to that. If you do, fine, and if not, that is fine as well.

Dr. CANNON. If I may, Mr. Chairman, an uneducated citizenry not only cannot do the job, but cannot afford to buy products from those who can. That is why your remark about the enduring nature of the problem of a lack of education, broadly, is so important.

Senator RIEGLE. This afternoon, we will start the budget markup process in the Budget Committee, where I serve with other colleagues from this committee.

We are presented with a recommendation for a 24 percent cut in education, including a very substantial amount for assistance for people in this country to go on to college. The figure, as it relates to States, would mean that in my State of Michigan, roughly $71 million would disappear that otherwise would be there to enable students to finance their advanced work beyond the twelfth grade.

So we are facing those decisions literally within a matter of two or three hours, as to whether we are going to drop the knife down on the education budget versus something else, or even perhaps to think about raising this additional revenue in order to pay those kinds of bills if we think these are important investments.

It is so interesting, if you will, to attend this hearing and to hear your emphasis on the need for education, as it relates to national

performance and living standards and productivity, and then, in turn, within a matter of a very short space of time, to be seated at another similar table in another room here to consider requests for very substantial cuts in education.

So, we will see what we can do over there.

I appreciate your testimony today. It has been very helpful to us.

This subcommittee is in recess.

[Whereupon, at 12:13 p.m., the subcommittee recessed, to reconvene upon the call of the Chair.]

ADDITIONAL ARTICLES, LETTERS, AND STATEMENTS

STATEMENT OF THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION

The American Institute of Steel Construction (AISC) is pleased to submit this statement for the record in connection with the hearings on the Fiscal Year 1988 Budget for the National Bureau of Standards (NBS). AISC's statement will focus on the critical need for continued full funding for the Center for Building Technology and the Center for Fire Research of the NBS.

The statement provides background information on the AISC and the U.S. fabricated structural steel industry. Our statement then discusses the impact of the proposed Administration action to reduce funding for the Center for Building Technology and the Center for Fire Research on the U.S. fabricated structural steel industry and upon consumers of steel building frames and bridges.

I. GENERAL BACKGROUND

A. The American Institute of Steel Construction [AISC]

AISC, headquartered in Chicago, is a unique voluntary trade association uniting the fabricators of steel framed buildings, bridges and related structures. AISC also serves the erectors, designers and educators who have professional interest in fabricated structural steel structures. AISC has three types of membership: Active, Associate, and Professional.

Active membership is open to companies that farbicate structural steel. Only firms headquartered in the U.S. are eligible. Active membership now totals 380 firms.

Associate membership is open to firms or individuals who sell a product or service related to steel construction (*e.g.*, mill steel producers, steel deck manufacturers, bolt manufacturers, etc.). Associate membership now totals 112.

Professional membership includes firms or individuals practicing as architects or engineers, or teaching either of these professions in a recognized college or university. Professional membership now totals 2,040.

In the early years of steel-framed construction, the growth of our industry was limited by the lack of standard design principles and descriptive product terminology. Producing mills each rolled different sections or shapes and each mill had its own weight load tables and product specifications. In many cases these were inconsistent with the standards of other mills. This condition had existed for many years and was the fundamental reason the AISC was formed in 1921. The original objectives for the AISC were thus: 1. to establish a single standard construction manual recognized by building authorities and designers; 2. to establish a set of standard loading tables for all the sections rolled by the various mills; and 3. the establishment of an authority to foster the efficient use of steel that would be welcomed by the mills, engineering profession, architects, building officials and purchasers of steel.

AISC believes it has accomplished those objectives with distinction.

During recent years AISC's traditional strong emphasis on research and engineering has been expanded to encompass a wide range of educational, market research, and producer certification programs. AISC and its affiliated marketing company have a full time staff of over 50 people and operate under an annual budget of $4 million.

Through its 66 year history, AISC has been highly engineering oriented with a strong emphasis on steel research and steel design techniques. It publishes many technical publications including the "bible" of the industry—the AISC Manual of Steel Construction—which contains the well-known AISC Code of Standard Practice for Steel Buildings and Bridges and the AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings. These documents are the basis for most steel bridge and building designs and construction contracts in this country as well as in many other parts of the world.

In April 1983, AISC established a full time office in Washington, D.C. to pursue the fabricated structural steel industry's interests before the Congress, the various federal agencies and with related or allied trade associations.

B. The U.S. Fabricated Structural Steel Industry

The fabricated structural steel industry manufacturers custom products for the construction industry. The principal products are steel building frames, bridges and related structures. The leading alternative construction material for these applications is reinforced concrete, which is also widely used throughout the United States. The choice between steel and concrete reflects to a large degree the particular engineering features of each structure, but price is also a major determining factor.

The structural steel fabricator plays a clearly defined and critically essential role in constructing a building or bridge. The fabricator works with the plans and specifications for the structure prepared by architects and engineers to determine the number and type of fabricated steel pieces that will be needed. Using steel shapes and plates purchased from the mill steel producers or steel service centers, the fabricator creates each of the required framing pieces. These fabricated structural steel parts are then properly grouped and transported to the construction site, where the building frame or bridge is assembled by an erecting company or the in-house erecting forces of the fabricator. Typically the fabricator is a subcontractor to the general contractor for the building or bridge.

The U.S. fabricated structural steel industry consists of approximately 1,100 firms, which are typically closely held family businesses. We estimate that the industry now employs approximately 53,000 persons, primarily ironworkers who fabricate steel in our plants. In this sense fabricate means cut, bend, drill or punch, weld or bolt pieces of steel. These ironworkers are supported by estimators, draftsmen, and management personnel.

An industry employing 53,000 persons among 1,100 firms is an industry whose firms average 48 employees. Thus, the U.S. fabricated structural steel industry is a large group of small businesses.

Steel fabricating firms are independent from the mill steel producers, which themselves generally do not engage in the fabricated structural steel business. Mill steel producers such as the Bethlehem Steel Corporation played a major role in steel fabrication until about 12 years ago but they have now largely left our business. It is widely believed that the mills withdrew from fabricating because their labor structures rendered them noncompetitive.

Bureau of Labor Statistics data show that employees of the fabricated structural steel industry earn a wage that is about two percent higher than the average industrial wage. About half of our workers are unionized.

Although the U.S. fabricated structural steel industry is separate from the mill or basic steel industry, the economies of the two are closely linked. The fabricated structural steel industry uses over five million tons of mill steel per year. As such it is a very important customer of the mill steel industry. Our total business volume is over $6 billion per year.

Approximately 55% of the cost of fabricated structural steel products is the price paid for mill steel. Thus, design economy in the amount of steel used and the unit cost of the mill steel affect our competitiveness with foreign fabricated structural steel and with concrete and other materials suitable for building and bridge construction.

The domestic fabricated structural steel industry presently is only marginally profitable. This reflects injury caused by foreign fabricators, including both actual lost contracts and suppression in the price of contracts secured by domestic firms. These effects are greatest in certain regions of the country, particularly the West Coast and the Northeast. Factors contributing to import pressure include the cost advantage enjoyed by foreign fabricators in the price of basic steel and the strength of the U.S. dollar.

Another factor affecting current profitability is the recession of 1982 which caused an overall reduction in the demand for fabricated structural steel products. Heavy construction is generally the last construction sector to rebound in a recovery but in this sustained recovery has yet to be restored. This is generally attributed to the surge in imports that are meeting demand without the normal growth in domestic production facilities. AISC estimates that total employment in the fabricated structural steel industry has fallen over 20,000 during the last six years and that we have experienced approximately 150 plant closings.

II. ISSUE OF FUNDING FOR THE CENTER FOR BUILDING TECHNOLOGY AND THE CENTER FOR FIRE RESEARCH

The Administration's budget for fiscal year 1988 proposes major reductions for the Center for Building Technology and the Center for Fire Research at the National Bureau of Standards (NBS). The American Institute of Steel construction (AISC) is seriously concerned about this proposal. The fabricated structural steel industry recognizes the centers' important contributions to building technology. We strongly urge that steps be taken to provide continuing full federal support for these two centers.

Throughout its 66 year history. AISC has been highly engineering oriented with a strong emphasis on steel research and steel design techniques. It publishes many technical publications including the "bible" of the industry—the AISC Manual of Steel Construction—which contains the well know AISC Code of Standard Practice for Steel Buildings and Bridges and the AISC specifications for the Design, Fabrication and Erection of Structural Steel for Buildings. These documents are the basis for most steel building and bridge designs and construction contracts in this country as well as in many other parts of the world.

AISC is involved in long range strategic planning to move our industry forward. Technology is one of the five key objectives in our strategic plan. Activities at the NBS are critically important to us in this regard. NBS has a long history of cooperation with the steel industry. For example, NBS has been working with the steel industry for more than 80 years to improve the durability and performance of metals and alloys. In 1985 in the structural engineering area, NBS worked with AISC, the American Iron and Steel Institute (AISI) and the Metal Building Manufacturers Association (MBMA) to develop a researh agenda for steel buildings.

The Center for Building Technology at NBS took the leadership role in bringing together representatives of the steel industry, federal agencies, design professionals and university researchers in a two day workshop. The participants identified experimental and analytical research needed to advance the state-of-the-art and improve safety and economy in the design, fabrication and construction of steel buildings. They also developed a five-year plan for a coordinated research program. The workshop was sponsored by NBS, AISC, AISI, MBMA and the National Science Foundation. The workshop proceedings were published as NBS Special Publication 693.

The concept of government/industry/university cooperation to carry out a coordinated research program was fully endorsed by the NBS workshop. Such cooperation is well underway. For example, the Center for Building Technology at NBS, the AISC and the University of Arizona initiated a cooperative research project in 1985 on the behavior of connections for steel braced frames. The project involves large-scale structural connections subjected to loads encountered in buildings subjected to wind or earthquakes.

Analytical studies at the University of Arizona, which have been going on for several years under AISC sponsorship, will serve as the basis for the cooperative project. The experimental program was developed by NBS researchers in consultation with representatives from a special AISC Task Group on Bracing for Heavy Construction and researchers from the University of Arizona. Computer studies of typical braced frame multistory buildings were conducted by the Bethlehem Steel Corporation to provide prototype values for member sizes, stress levels and connection details. These studies were used to design the test set up and select the dimensions of the test specimens to insure that the tests closely simulate the behavior of bracing members and connections in actual structures. The test specimens were fabricated in accordance with current practice and donated by the Cives Steel Company. The experimental program began at NBS in 1986. It utilizes unique experimental facilities available in the Center for Building Technology.

We believe this cooperative government/industry/university venture will serve as a model for future cooperative efforts in building research. It draws upon the expertise and resources of the three groups. It also illustrates the vital role the Center for Building Technology with its unique laboratory facilities and technical staff can play in improving building practices in the United States.

The AISC recognizes the need for and shares the commitment to reducing the federal budget deficit. However, we believe the services provided by the Centers for Building Technology and for Fire Research at NBS are critically important in providing advanced technology needed for the growth of the U.S. fabricated structural steel industry. We strongly urge the Congress to take steps to insure the continuation of full funding for the two centers.

CONCLUSION

This statement for the record documents the strong views of the American Institute of Steel Construction, the national voice of the fabricated structural steel industry, on the critical importance of continued full funding support for the Center for Building Technology and the Center for Fire Research. Only through the operation of these two centers can meaningful technological progress in steel construction continue.

STATEMENT OF THE AMERICAN TEXTILE MANUFACTURERS INSTITUTE

The American Textitle Manufacturers Institute (ATMI) believes that the National Bureau of Standards (NBS) fire research program is an important contributor to the ongoing national effort to reduce fire deaths and injuries. Better understanding of the complex fire phenomena, particularly in the area of combustion toxicity, is essential to making our country more fire-safe. Extensive work currently is being conducted to understand more about the by-products of combustion and their transport in buildings since it is generally recognized that more fire deaths are caused by toxic by-products than directly from fire.

Results of work from the Center for Fire Research (CFR) are being used now. The Center last year announced the availability of the Fire and Smoke Transport (FAST) Model. Computer models of this type will permit a realistic assessment of the relative contribution of key fire variabiles including ease of ignition, rate of heat release, smoke generation and toxicity. More importantly, the models will provide the mechanisms for more cost-effective life safety systems to reduce building fires.

CFR has also developed a unique system to measure smoke toxicity from burning materials which may substantially reduce the need for animal testing. This system, known as the "N-gas model" uses both analytical chemistry and bioassay approaches to predict the toxicity of materials. Main benefits are faster speed and lower costs than the bioassay approach only.

Therefore, we believe that the CFR possesses unique research capabilities and experience that cannot be duplicated by other sectors, either public or private. Left to the state and local governments and the private sector, this research, if conducted at all, would be fragmented, unfocused and much less effective in attacking the serious, continuing fire problems facing our nation.

For the reasons stated above, we support the Center for Fire Research at NBS and urge that the CFR be funded for 1988 at a level at least equal to that of 1987. A continuing CFR program is necessary to reduce the fire death rate in the United States, which ranks last, along with Canada, among reporting nations.

ATMI appreciates this opportunity to state our support for the continuation of the CFR and to emphasize the valuable contribution the Center makes toward the solution of our national fire problem.

STATEMENT OF JOSEPH G. O'GRADY, PRESIDENT OF ASTM

I am Joseph G. O'Grady, President of ASTM. I would like to state a few things about ASTM to lay the ground work for why we are making this statement for the record.

ASTM, formerly known as the American Society for Testing and Materials, is the leading standards organization in the world for the development of voluntary consensus standards for materials, products, systems, and services. Its 140 standards writing committees annually publish nearly 8,000 standards to meet the needs of industry, government, academia, testing agencies, and the service sector of our economy. The ASTM committees cover a wide spectrum of subjects to include ferrous and non-ferrous metals, ceramics, waste disposal, construction materials, petroleum, textiles, fire standards, medical services, biotechnology, and consumer products. Since its formation in 1898, ASTM has expanded to include some 30,000 members, of which over 3,800 are international.

Both the Bureau and ASTM were founded to help develop a firm measurement base for this country's industrial revolution at the turn of the century. Both organizations have experienced remarkable growth over the years and have developed a working relationship that has been mutually satisfactory and productive.

ASTM does not normally participate in the business of government; nor does it take a position on national policy issues. For the past several years, however, we have made one, and only one exception to this rule. We have offered our views to

this Subcommittee on the importance of supporting and maintaining the life of the National Bureau of Standards because that life had been threatened by severe budget cutbacks.

The work of the National Bureau of Standards creates basic substructures upon which this nation's standards are built. ASTM produces nearly 8,000 standards; more, we believe, than any other organization in the world. The integrity of these documents is recognized in every corner of the globe. This would not be so without the participation of the almost 300 scientists and engineers of the Bureau in the work of our technical committees. This could not be so without the basic research, reference materials, and advanced measurement techniques developed by the Bureau.

We cannot stress enough the importance of this relationship.

It is almost impossible to go through a day without hearing the words "industrial competitiveness." The stunning, widespread and relentless foreign intrusion into this country's economy has created the buzz words of 1987. We hear them in the technical community as well; for the nation's industrial problems eventually become standards problems.

For the record, we believe that the research arm of the government must be fully supported by the Congress. Only then can it support us. And only then can a strengthened U.S. industry make us more competitive in the world's markets.

We are happy to see that this year the Bureau does not have to face near-fiscal-extinction.

In addition, we wish to state our belief that every program within the Bureau is vital, that the work of the Bureau is one of this country's greatest assets, and that it should suffer no loss.

We commend Senator Riegle and the members of this subcommittee for their unstinting support of the Bureau through difficult times. May their continued support carry it into a secure future.

BROWN UNIVERSITY LIBRARY,
Providence, Rhode Island, February 9, 1987.

Hon. CLAIBORNE PELL,
335 Russell Senate Office Building,
Washington, DC.

DEAR SENATOR PELL: The technical reports produced and made available to libraries through the National Technical Information Service (NTIS) are fundamental to research in the hard sciences and engineering, where the most current information is critical to ongoing projects. At a time when many people in the United States—including the present Administration—are increasingly concerned about competition from abroad, both economic and military, this is no time to put our capability to do scientific research at risk.

For this reason, I was distressed to learn that Appendix I-F9 of the President's proposed budget for FY 1988 contains the following statement: "In 1988, the private sector will be offered the opportunity to operate NTIS on contract, with the government retaining overall policy direction."

Librarians nationwide are concerned about the Administration's continuing efforts to remove the production and dissemination of public information from the list of Federal responsibilities. We are seeing these efforts in a variety of areas: in the decision by the Superintendent of Documents to produce certain vital publications only in microfiche, thus delaying their availability to the public for as much as three months; in the disappearance of some important Government publications altogether; and in the repeated insistence by the Administration that many of these crucial titles can be turned over to the private sector with no concomitant risk to the American public.

The latter belief is particularly destructive because it is untrue. The private sector, unlike the U.S. Government, has no obligation to see that the people are informed; it publishes solely to make money, and it prices its publications accordingly. Since library budgets have failed dramatically to keep pace with the inflation in the cost of published materials, more and more libraries will find it impossible to subscribe to the higher-priced NTIS products and services which will undoubtedly result from privatization. The users of these libraries will thus be deprived of information which might be vital to their research.

There are other hard questions about privatization which must be asked, particularly in light of the simplistic argument that privatizing NTIS will "streamline" services and hence reduce cost. Will a private sector contractor be willing to assume the obligation of making all reports in the collection available, no matter how old? How will a private contractor deal with the Federal agencies which produce NTIS reports, not to mention with governments abroad? What will happen to the service

if the contractor finds the whole business too burdensome and fails to renew the contract?

There has been very little detail about how the Administration would propose to go about the privatization of NTIS. I understand, however, that two congressional subcommittees are considering hearings on the OMB proposal, perhaps in early March. Because the decision on this issue will affect the degree to which the citizens of Rhode Island will gain access to needed information, I felt that you would wish to be informed and that you will want to give some attention to the matter. I believe that there should be a thorough Congressional review of the implications of this OMB recommendation.

As always, your support for libraries and for our citizens' right to be informed is greatly appreciated. Best wishes.

Sincerely yours,

MERRILY E. TAYLOR,
University Librarian.

STATEMENT OF THE IEEE ENGINEERING R&D COMMITTEE

As the largest technical professional society in the world, the IEEE has a very special interest in the vigorous growth of technology and its productive application to serve people's needs both here and abroad. Our 228,000 members in the United States are engaged in advancing the frontiers of knowledge across a broad range of important and fast growing technologies that are vital to our national industrial competitiveness and our defense systems. We are, therefore, particularly interested in Government programs that support those efforts.

In this regard, we wish to address the elements of the proposed Federal Budget that affect programs of the National Bureau of Standards in computer science and technology, such as specifications and conformance standards, and on product measurement science, such as precision measurement standards for electrical, electronic, microwave, millimeter wave, fiber optic and optical electronics. This statement has been endorsed by the American Association of Engineering Societies (AAES), a multidisciplinary organization dedicated to advancing the knowledge, understanding and practice of engineering in the public interest. Its members represent the mainstream of U.S. engineering -- over half a million engineers in industry, government and education.

The National Bureau of Standards has a legitimate role of government in supporting the Nation's science and technology base. It is the unbiased arbiter of numerous technology issues relating to metrology, the science of measurements. The NBS Organic Act of March 3, 1901, wisely recognized this central, basic role of NBS as the leader and technical support structure for weights and measures elements of our economy and commerce. As technology has advanced and become more complicated, the role has taken on even greater significance. It now provides a sound national system upon which physical quantity measurements are based that are vital to new product research, productivity, assurance of quality, maintenance of equity in trade and in a multitude of defense and space applications. We see it as the most important component of all the Department of Commerce efforts to advance, aid and support American industry.

Yet, despite the critical and elemental role of NBS to the vitality of America's industry and technology, it has historically been underfunded to execute its basic role and the additional tasks assigned to it over the years. It has been burdened with programs and assignments that have been important to the national interest and which the excellent scientific knowledge base of the Bureau has been competent to fulfill. Nonetheless, these added programs were not matched with needed funds. Typically NBS has been provided initializing funds for new projects far less than the projects needed, with intentions for future increases. These intentions were rarely carried out and NBS's basic metrology mission suffered funding depressions, as did other added tasks, in an effort to satisfy a succession of Administrations and Congresses.

All of this has left NBS in a weakened condition in terms of finances, manpower and technical vitality. We feel that the funding level of NBS should exceed $200 million per year. We are pleased to see an increment towards this goal in this year's budget. The history of NBS budget requests to the Department of Commerce has shown levels consistently in excess of $200 million. However, the requested amounts have not been passed on through DOC and the Office of Management and Budget. While this $200 million level is needed immediately, in

recognition of the federal deficit posture we would recommend that the NBS budget be built up to at least $200 million over a period of three to five years. In parallel with this, we recommend the involvement of technical and industrial organizations with NBS to outline a plan to set priorities and actions to restore NBS as a fully adequate resource.

We were pleased to note that the 1987 Authorization Act included an alternative personnel management system for NBS scientific and engineering personnel modeled after a similar successful program at Navy Laboratories at San Diego and China Lake, California. This was an outgrowth of the efforts of the Honorable Don Fuqua, former Chairman of the House Committee on Science and Technology to implement concerns expressed by Hon David Packard reflecting the views of the White House Science Council's Federal Laboratory Review Panel. It allows the Director of NBS to pay more competitive salaries to attract, motivate and retain NBS's most essential element, its scientists and engineers, and to improve the overall ability of the Bureau to manage and perform scientific and technical work. However, even with this enlightened tool at hand, it is understood that the government will continue to skimp unwisely on this valuable program by not providing increased funding to pay for it. So history will repeat itself. A New program without new funds; new funds taken out of current programs; overall effectiveness reduced; a gain turned into a loss. Those who impose such restrictions are short sighted and obstructive of the program's objectives. Additional funds should be added to the NBS budget immediately to allow an orderly and reasonable implementation of the plan without still further detriment to existing programs. This is particularly important since we expect the NBS demonstration program to show the way to better management of one of the government's key resources, its scientists and engineers.

COMPUTER SCIENCE AND TECHNOLOGY PROGRAMS

The United States has long been recognized as the World leaders in computer technology. Yet, today, our computer industry is in serious trouble. As recently as last year, this industry provided a healthy positive counterbalance to our international trade deficit. However, we are now fast approaching a negative balance which portends a hastening of decline of even this last bastion of US technological dominance. we feel strongly that there is a legitimate, necessary government role in supporting the competitiveness of this industry.

One of the key government functions that provides an underlying basis for our technological society and production mechanisms is support for the development and implementation of industrial standards of conformity. These are written technical standards and specifications prepared to assure the form, fit and functional compatibility of equipment and systems developed and built for US and international markets. These include standards developed and established by the Government for its own use in defining and acquiring products and services. It also involves those national and international industrial standards development activities which the Federal Government supports through widespread participation in voluntary standards efforts.

The IEEE is a major partner in many of these efforts. As a result, we in the IEEE are very strong supporters of a healthy standards program within the NBS as an important and unique contribution to our nation's industrial competitiveness. The NBS plays a major role in these nationwide activities. In the case of computer standards and specification, the critical operating unit in NBS is the Institute for Computer Science and Technology (ICST). Its program supports the Department of Commerce goals of promoting the development and application of science and technology in US industries and increasing their competitiveness. It is especially meaningful and essential to the Department's goals in products and services growth and exports in telecommunications, computer and information products and related services. It aids the DOC in assuring the development and acceptance of US generated technical standards based on US technology and manufacturing methodology. It further improves the Federal Government's cost-effective use of computer and telecommunications technology, as the largest single user of the technology in the nation.

The IEEE strongly supported the DOC goals in this matter. They are consistent with the IEEE's concern for the technical and economic health and vitality of US industry and of its relative position in the world marketplace. In this connection, we are seriously concerned with the funding levels planned for the ICST in 1988. The Institute was funded at $10 million in 1985, $9.6 million in 1986 and $7.5 million in 1987. The 1986 level was inadequate; the 1987 was devastating. It is the IEEE's position that a failure to fund at adequate levels will lead to a major loss to US industry and seriously handicap its competitive posture in domestic and international markets. We strongly support a funding level equivalent to the 1985 level of $10 million, adjusted upward for inflation. This should be followed by real increases to bring the ICST to a funding level of at least $15 million in current dollars.

The Government spends over $15 billion annually on information technology. Cost benefit studies by independent consultants have identified over $300 million in Federal cost savings for data-base software standards alone. Comparably large savings are anticipated through standards being completed in the areas of networking protocols, computer security, and computer based message systems. Computing technology is at the heart of efforts to improve productivity and cut costs in government, industry and business. Computer hardware, software and communication standards is one of the areas of greatest cost leverage. This is where the ICST provides crucial national leadership and coordination that maximizes compatibility and efficiency.

Funding of the ICST to increased levels is a sound investment. The ICST is a source of objective, independent input while representing the interests of the Federal Government as a larger user of information technology. Its staff serves a key role in over sixty voluntary industry standards committees, providing critical technical input concerning technical specifications, and in the measurement and testing of the draft standards. Their participation further assure the necessary continuity and impetus to the standards drafting process, a process which easily stalemates without the presence of independent, but highly motivated participants representing consumer viewpoints. For example, it is clear that the many suppliers of computer networking services need the unifying force of an unbiased, internationally recognized and respected third

party if we are to avoid an uncontrolled, disruptive, and wasteful proliferation of incompatible computer hardware and software that would be chaotic to both users and vendors, but especially to users such as the Federal Government. This has been the role played by the ICST in developing and facilitating the adoption of key standards. It provides a fundamental underpinning for the computer industry which enhances productivity and market demand while leveraging innovation into new products. We are dismayed at the 1987 cuts in the ICST's networking program and place a high priority on restoration of these funds.

The Institute for Computer Science and Technology at NBS is a small and fragile resource in the much larger Department of Commerce structure. It has, however, a key role that far exceeds its size. In fact, its small size versus its impact is evidence of the economy of this highly effective program at a time when competitiveness and negative trade balances are of such major concern. The private sector is neither able nor willing to substitute for the unique role of the ICST. This position and the importance of the ICST has been underscored by the many distinguished witnesses that have given testimony before the Congress over the last several years. We join them in support of the ICST. We believe that funding of the ICST at increased levels will produce a highly leveraged return on investment. For example, we feel the ICST should have standards research underway in the area of reliability recovery and integrity of complex computer systems. Both government and the private sector rely increasingly on such systems. An expanded role for the ICST is of high national interest as a vital element to a healthy and vibrant information technology infrastructure in the United States and in competition in worldwide markets.

MEASUREMENT SCIENCE AND PRECISION MEASUREMENT STANDARDS

There has been a steady decline in the capability of the Federal Government to assure the veracity and authenticity of precision measurements used in the marketplace and in defense programs. U.S. industry needs precise state-of-the-art measurements and measuring systems to provide advances in technology, to perform research, and to design better, more competitive equipment. Precisely controlled measurements are at the heart of technological advancement and product competitiveness. The ability to do this gives a nation the edge in worldwide technology commerce. We are gravely concerned that work on more precise and accurate measurements in the USA is slipping badly, as is our relative world position in making and controlling extremely accurate measurements.

Early in this century our Government recognized its basic role to maintain and disseminate such measurement standards as to assure the equity of trade and of the marketplace. That is, in the conduct of commerce, they wanted industrialists to know that they were manufacturing and buyers to know what to expect to get for their money. That basic role is unchanged to this day and its need is far greater as increasingly precise and complex new technologies have appeared. This fundamental and basic role is contained in the Organic Act of 1901 with numerous recent amendments. It assigns mission and functions to the National Bureau of Standards (NBS) that encompass this role. IEEE supports the intent of the Organic Act that the fundamental function of NBS is the research, develop-

ment and dissemination of adequately precise and accurate measurements, measurement standards, and measurement methods. This is its central role. They are considered the leaders and arbiters of the national measurement system as a legitimate function of centralized government. It is the view of the IEEE that all other NBS functions that compete and interfere with these activities, while important in and of themselves, are of less importance and of lower priority.

Economic estimates have shown that $160 billion per year are spent on measurements in the USA. These measurements are derived from an overall national resource that can best be described as a national measurement system. While the National Bureau of Standards are the leaders of the national measurement system, this leadership role has been subverted by numerous events and erosions that have seriously weakened the resources of NBS to conduct its fundamental business. Inadequate funding for these most basic functions is at the heart of the atrophy and neglect of NBS. Needed technological advances in measurement to parallel advances in science and engineering are not happening. The tools for the Nation's leading engineers and scientists are not there when needed.

The transfer of technology from research laboratories into manufacturing is vitally linked to precise, accurate, and adequate measurement capability. Manufacturing process and product quality are highly dependent upon precision measurements. All measurements in the USA must be linked to common measurement references to avoid chaos in the laboratory, factory and marketplace. It is the assigned role of the NBS to furnish those common measurement references; yet, NBS has not been furnished the financial support to do the job. All of science and industry suffers and our economy pays the price. Manufacturing of innovative products is seriously delayed if no adequate means exists to precisely and accurately measure the new technology that is discovered. Defense and space capabilities are needlessly limited and endangered by inability to more precisely measure and control systems.

When the NBS does not perform, U.S. industry must turn to foreign makers of precision measurement equipment for our needs, or develop their own measurement methods and systems. In either event, we are faced with increasing foreign market dependence or the needless duplication and expenditure of scarce resources for advanced technology projects. If NBS could do its job, the foundation for measurement resources would be there, the foreign dependence could be avoided, and the wasted effort could be used to advance America's competitive position. Proper funding and priority placement is the key to NBS success in this most basic function. Necessary emphasis and requirements must be placed on the Department of Commerce and the NBS to assure this success and to maintain proper focus on measurement science and technology.

The lack of adequate resources in the DOC to meet the needs of the national measurement system particularly impacts the needs of the nation in electronics technology. This technology forms the largest manufacturing group in the U.S. with 2.3 million employees. The $215 billion electronics market represents about 5.5% of the gross national product and is growing. Export of electronics equipment is now about $40 billion. Exports exceeded imports by $5 billion five years ago, but it is now reversed. In 1985 electronic imports exceeded exports by $9 billion; the 1986 estimate is for a $12 billion imbalance with the trend

toward even greater trade deficits in future years.

In some frequency bands such as those needed for new satellite communication systems, no adequate NBS measurement standards capabilities exist. Because of increasing concern for the future of measurement capability to support electronics technology, two groups have merged within the IEEE to examine the problem and explore immediate and long term actions to regain lost ground and to achieve the high ground, once again. These engineers come from component, instrument, and system manufacturers, whose frustrations and concerns have reached such levels that they believe alrams aneed to be sounded. Their studies to date reveal that the NBS's measurement science capability has fallen behind more seriously than originally imagined by the technical community. They conclude that, while private industry can contribute to electronics measurement technology, the NBS has the fundamental technical and leadership role with regard to the national measurement reference standards segment. They further realize that research into new measurement frontiers must take place at the national reference level in advance of, or, at least in parallel with advances in industry. Most desirably, the advances through NBS research would function in an iterative process with NBS and industry working together in teamwork. There is no way this can happen in the current weakened funding environment at NBS. Private funding to supplement NBS's current funding may sound attractive, but the two IEEE study groups and many others conclude that expectations of a simultaneous uprising or mutually compatible and motivated companies is highly unlikely, although ideally attractive as a substitute to increased government funding.

The need for measurement technology support for electronics covers the entire electromagnetic domain from direct current to optical systems. In the lightwave measurement technology area, which includes fiber optics, deficiencies are most pronounced at power levels of 1 to 200 milliwatts at wavelengths of 600 to 860 nanometers and from 1 to 8 milliwatts at 1300 to 1550 nanometers. Attenuation measurements and related primary standards are also deficient from 0.1 to 100db at accuracies at the test set usage level of 0.1db/10db. In the millimeter wave and microwave technology area, some 75 specific deficiencies in combinations of frequency versus measurement parameter were exposed by a recent IEEE study. The amount needed over the next five years to correct the most serious deficiencies has been estimated at $38 million. These include power, attenuation, impedance and thermal noise in the millimeter/microwave frequency spectrums above 18 GHz where the highest priority needs were identified. In the areas of general electronics measurement, known within NBS as product control and quality assurance, deficiencies exist in alternating current measurement standards for support to devices at accuracies of better than 5 parts per million from 40 KHz; more accurate four terminal-pair impedance measurements to 10Mhz; and transportable capacitance standards of greater stability and environmental resistance.

These are but a few of the many deficiencies that need immediate attention. These are the needs that form a major backlog of measurement standards projects at NBS. They must first be overcome before progress can be made to aid industry in advancing measurement science to support the electronic industry and electronic technology. An infusion of funding is essential to catch up with the backlog and to develop technical muscle at NBS to undertake new research and

development of advanced measurement capabilities. We estimate that an additional amount of $25 million per year for the next 5 to 7 years is needed to get back on solid ground and rebuild our national measurement standards competence.

The IEEE considers this matter of great importance to the national interest. We have recommended to the Department of Defense that such measurement deficiencies imperil our defense systems and have urged a study within DOD to explore existing and future needs and solutions. The Congress may wish to have the Office of Technology Assessment undertake a similar study in the broader national interest.

The IEEE statements made herein seek to awaken all of those in our nation involved with protecting and promoting our most fundamental technical resources. Measurement and their underlying calibrations seem to be taken for granted by many otherwise knowledgeable people, just as the millions of measurements associated with production and readiness inspections of such systems as the space shuttle were taken for granted. Until something goes wrong, few realize the significance that precise, accurate and dependable measurements play in our high technology culture. Our national measurement resources require constant maintenance just to retain our momentary position. To advance technically, our measurement capability must advance. Both maintenance and advancement must receive our constant vigilance and attention to avoid the atrophy that can create disasters at worst, and delays at best.

SUMMARY

The specific concerns of the IEEE regarding the Department of Commerce budget for the National Bureau of Standards are as follows:

(1) That the overall NBS appropriation should reach levels greater than $200 million as soon as possible. Numerous programs are underfunded and weaken the effectiveness of all NBS programs as a result.

(2) That the NBS demonstration personnel management program be provided necessary funds for earliest possible implementation. The lack of added funds to start the effort is false economy and can only damage programs already in place.

(3) That funding in 1988 for the Institute for Computer Science and Technology (ICST) be raised to levels equivalent to $10 million in 1985 dollars. Cuts made to the ICST funds over the past few years have had a serious detrimental effect on the degree of ICST contributions to the needs of the U.S. industry and to its users. Over the next three to five years, ICST funding needs to be raised to $15 million.

(4) That the budgeted amounts for fiber optics, millimeter wave/microwave, and product control and quality assurance be increased by $25 million over amounts received in 1987. This year's DOC budget requires for funding for NBS is inadequate to support the most basic needs of the

measurement standards elements and programs of NBS. Some small increases have been requested for lightwave measurement technology and product control and quality assurance. None have been requested for millimeter wave and microwave, which is most disappointing. All three of these areas need a major infusion of funding. Lightwave measurement technology needs an additional $9 million, product control and quality assurance needs an additional $8 million, and millimeter wave and microwave needs an additional $8 million. All of these areas have had visibility as initiatives in former budget submissions and were extremely deserving of support then, but in significantly increased amounts.

(5) That competing program within NBS not be allowed to siphon funds from the above measurements standards programs if reductions are levied against these other programs, or if funds are added to the measurement standards program.

(6) That where the DOC or OMB have included requests for funding of initiatives that address the measurement technology deficiencies disclosed in this statement, they receive the highest priority. Such initiatives have made their way into the budget process in the last three years, only to be eliminated or out-ranked by other non-measurement technology efforts. While many of these other initiatives are technically attractive, their presence results in the atrophy of the measurement standards resource. Although a zero growth or shrinking budget base has existed at NBS over the past several years, new programs and projects have been added. These, typically, have resulted in further draining of funds available to the measurement technology programs at NBS. We are opposed to any such actions. Our recommendation to raise the NBS budget above the $200 million level should provide some relief to the destructive financial conflicts that now exist.